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RHODE ISLAND AREAWIDE WATER QUALITY MANAGEMENT PLAN

INVENTORY REPORT

URBAN RUNOFF TASK

Prepared Pursuant to Title II, Section 208,
Federal Water Pollution Control Act Amendments of 1972

for the
RHODE ISLAND STATEWIDE PLANNING PROGRAM

Contract No. 77-27
August 1977

GC
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.R4
R3343
1977

RAYTHEON COMPANY
OCEANOGRAPHIC AND ENVIRONMENTAL SERVICES



ERRATA SHEET

Rhode Island Areawide Water Quality Management Plan

Urban Runoff Task

The following pages contain corrections of the most serious errors found in the Urban Runoff Task Inventory Report.

The pages have been punched for insertion in your report.

We regret any misunderstanding that may have resulted from these errors.

<u>Page</u>	<u>Change</u>
v	"Figure 7-16" found on page "7-37" should read page "7- <u>39</u> ".
vi	"Table 7-2" found on page "7-38" should read page "7- <u>40</u> ".
vii	..."m ² "... should read ..."mi ² "...
1-1	eleventh line..."be determination"...should read..."be <u>a</u> determination"...
1-2	sixteenth line..."separtely"...should read..."separ <u>a</u> tely"...
1-2	seventeenth line..."The"...should read..." <u>They</u> "...
3-1	ninth line..."Section 5"...should read "Section <u>6</u> "...
5-4	eighteenth line..."discharge"...should read..."dis- charged <u>a</u> "
5-4	twenty-seventh line..."have more"...should read..."have <u>a</u> more"...

<u>Page</u>	<u>Change</u>
6-19	eighteenth line..."have a significant"...should read ..."have significant"...
6-28	seventeenth line..."Practise"...should read... <u>Practice</u> "...
6-35	page 6-35 should be page 6-3 <u>6</u>
6-36	page 6-36 should be page 6-3 <u>5</u>
6-37	page 6-37 should be page 6-3 <u>8</u>
6-38	page 6-38 should be page 6-3 <u>7</u>
6-56	twenty-first line..."involues"...should read..."invol <u>ves</u> "...
7-36	page 7-36 should be page 7-3 <u>8</u>
7-37	page 7-37 should be page 7-3 <u>9</u>
7-38	page 7-38 should be page 7-4 <u>0</u>
7-39	page 7-39 should be page 7-3 <u>6</u>
7-40	page 7-40 should be page 7-3 <u>7</u>
7-50	fourteenth line..."92 acre"...should read..." <u>10</u> acre"...
7-86	twenty-sixth line..."approval"...should read..."ap- <u>proved</u> "...
7-87	twenty-seventh line..."All but one community"... should read..."All the communities"...
7-92	nineteenth line..."numicipal"...should read..." <u>municipal</u> "...
7-93	ninth line..."one ties"...should read..."one <u>communi</u> - ties"...
8-1	sixteenth line..."Level 1"...should read..."Level <u>I</u> "...

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AREAWIDE WATER QUALITY MANAGEMENT PLAN

INVENTORY REPORT

VOLUME II: SECTIONS 9-12

URBAN RUNOFF TASK

August 1977

By

RAYTHEON COMPANY
OCEANOGRAPHIC & ENVIRONMENTAL SERVICES
Portsmouth, Rhode Island 02871

Contract No. 77-27

Prepared Pursuant to
Title II, Section 208
Federal Water Pollution Control Act
Amendments of 1972

Prepared for
RHODE ISLAND STATEWIDE PLANNING PROGRAM
265 MELROSE STREET
PROVIDENCE, RHODE ISLAND 02907

U. S. DEPARTMENT OF COMMERCE NOAA
COASTAL SERVICES CENTER
2234 SOUTH HOBSON AVENUE
CHARLESTON, SC 29405-2413

GC1212.R4 R3343 1977

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Rhode Island Statewide Planning Program

ABSTRACT

This report was prepared to provide data for the determination of the importance and magnitude of urban stormwater runoff as a source of non-point pollution in the Rhode Island 208 area.

A detailed investigation of literature pertinent to the problem has been completed and included in the report. Methods available to control urban stormwater runoff, available analytical techniques for assessment of runoff, characteristics of urban stormwater runoff, and urban stormwater runoff problems similiar to those found in the study area have all been examined.

Selected data from Federal, State, and local governments as well as physical reconnaissance are presented along with an analysis of these data.

A separately-bound packet of urban drainage area and land-use maps is included with the report.

CONTENTS

9.	References	9-1
10.	Annotated Bibliography and Bibliography	10-1
11.	Glossary	11-1
12.	Appendices	12-1
	A. Water Quality Criteria	A-1
	B. Survey Questionnaire - Inventory Data . .	B-1
	C. Table of Problem Areas and Affected Receiving Waters	C-1

SECTION 9 REFERENCES

Section 4

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SECTION 10

ANNOTATED BIBLIOGRAPHY & BIBLIOGRAPHY

The annotated bibliography presented here results from a comprehensive literature search intended to augment the existing stormwater runoff library at Raytheon OES. Those items included in Raytheon's existing library prior to the search, are tabulated in the Bibliography. The new items added to the library as a result of the search are presented in this Annotated Bibliography.

The objective of the literature search was to identify pertinent technical literature on the following topics:

1. urban stormwater runoff problems in areas similar to the Rhode Island 208 area
2. characteristics of urban stormwater runoff
3. analytical techniques available to assess urban stormwater runoff
4. methods available to control urban stormwater runoff.

The search was limited to recent years, because greater attention has been paid to urban runoff during that period, giving a higher return on search time spent. Some well known older items are also included, because of their importance to the field of knowledge. In addition, some references on rural runoff and the general field of non-point pollution are included, because of Raytheon's responsibilities for certain aspects of these problems.

The entries resulting from the search are presented on a Document Summary Form containing both the citation and reviewer's summary. Each document reviewed has been assigned a Document Number in one or more Categories. No special significance should be attributed to the Document Number; it was assigned in the order of review and is useful for identification of the document. The Category designation is used to group together

documents on related topics. Table 10-1 summarizes the meanings of the Category designators. Table 10-2 provides an index of all documents assigned to each Category for rapid reference.

Section 5 of the report contains a synopsis of this literature search as it relates to urban runoff in the Rhode Island 208 area.

TABLE 10-1. ANNOTATED BIBLIOGRAPHY CATEGORIES.

Letter Designation	Meaning
A	Lab analytical techniques
C	Characteristics of runoff
E	Engineering analysis methods
I	Instrumentation
L	Load reduction methods (pre-storm event)
M	Load management methods (during storm event)
P	Policy
R	Receiving waters effect
S	Sampling
T	Treatment processes

TABLE 10-2 . CATEGORY INDEX FOR ANNOTATED BIBLIOGRAPHY

Document Number	Category									
	A	C	E	I	L	M	P	R	S	T
1						X				
2	X			X	X	X			X	X
3			X		X	X				
4				X	X	X		X	X	X
5					X		X	X		
6							X			
7			X							
8			X							
9					X			X		
10					X			X		
11			X			X				X
12							X			
13			X							
14			X							
15	X	X	X	X	X	X	X	X	X	X
16			X							
17	X	X	X	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X	X	X	X
19			X							
20						X		X		
21			X							
22	X	X	X	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X	X	X	X
24			X			X		X		
25		X	X							
26					X					
27						X				X
28	X	X								X
29		X						X		
30		X						X		

TABLE 10-2 . CONTINUED

Document Number	Category									
	A	C	E	I	L	M	P	R	S	T
31							X			
32							X			
33		X			X					
34		X						X		
35		X	X			X	X			
36			X			X	X	X		
37			X				X			
38	X	X		X					X	
39			X							
40			X	X						
41			X	X					X	
42						X				X
43		X								
44	X	X	X	X	X	X	X	X	X	X
45		X								
46		X	X			X				X
47		X					X			
48						X				
49		X						X		X
50	X	X		X					X	
51			X							
52		X	X							
53			X			X				
54			X							
55			X							
56							X			
57			X			X				
58							X			
59							X			
60			X			X				

TABLE 10-2 . CONTINUED

Document Number	Category									
	A	C	E	I	L	M	P	R	S	T
61			X							
62			X							
63			X							
64								X		X
65			X							X
66	X	X	X	X	X	X	X	X	X	X
67		X	X		X					
68			X							

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RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 1

CATEGORY: M

Title Design and Construction of Sanitary and Storm Sewers

Author(s) Joint Committee of WPCF and ASCE.
Affiliation(s)

Publication or WPCF
Publisher Washington, DC

Publication Date: 1970 Volume/Issue/Report No.: WPCF Manual of Practice #9

Summary: Standard sewer design manual.

Reviewed by: C. Beckers

Date: May 19, 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 2
CATEGORY: S,A,I,M,T,L

Title Methodology for the Study of Urban Storm Generated Pollution and Control.

Author(s) R.E. Wullschleger, A.E. Zaroni, C.A. Hansen
Affiliation(s) Envirex, Inc.
Milwaukee, WI 53214

Publication or USEPA Municipal Environmental Research Lab
Publisher Cincinnati, OH 45268

Publication Date: August 1976 Volume/Issue/Report No.: EPA-600/2-76-145

Summary: Due to lack of standardization, it is often difficult to make comparisons between or combine data from various stormwater programs. The report proposes standard approaches and methods in 6 areas of stormwater analysis:

1. Sampling and sample preservation
2. Monitoring instrumentation
3. Choice of water quality constituents to be analyzed.
4. Sample analysis methods
5. Impact evaluation methods
6. Treatment process evaluation methods.

Emphasis of report is on areas 1, 2, 3, and 4. Area 6 is given more emphasis than area 5. While the report makes strong recommendations and has the aura of authority for standardization in these areas, its effect is limited by the EPA disclaimer attached and by the 1 year and 8 month delay in its publication. Presents a comprehensive review of the important factors to be considered in stormwater runoff and techniques for dealing with those factors. For receiving waters, recommends few intense surveys over longer duration low intensity data acquisition.

Reviewed by: C. Beckers

Date: May 19, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 3

CATEGORY: L,M,E

Title Evaluation of the Cost-Effectiveness of Non-Structural
Pollution Controls: A Manual for Water Quality Management
Planning

Author(s) F. Rueter and C. Fox
Affiliation(s) CONSAD Research Corporation
121 North Highland Avenue
Pittsburgh, PA 15206

Publication or
Publisher Environmental Protection Agency
Planning Assistance Branch
Washington, DC 20466

Publication Date: 4/30/76 Volume/Issue/Report No.: PB-260 513

Summary: The report reviews the important non-engineering aspects of evaluating non-structural pollution control methods. Aspects considered are: legal feasibility, private costs and benefits, social costs and benefits, public and private administrative costs, procedures for evaluating changes in land values, employment and income effects, tax base effects and just compensation. Some specific non-structural controls discussed are: regulatory controls, growth management controls, eminent domain controls, pricing and taxation controls, and planning process controls. The focus is on actions that may affect private property, as opposed to those non-structural controls, such as street sweeping, that are routinely within the public domain. Report provides a number of "check-list" forms for evaluating candidate actions. Emphasis is on "cost-effectiveness", not "cost-benefit", just as in Raytheon's work on sampling systems; the stream standards are taken as objectives. Many ref's to the "208 Guidelines", etc.

Reviewed by: C. Beckers

Date: May 20, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 4

CATEGORY: S, I, M, T, R, L

Title London's Stormwater Problem

Author(s) R.W. Horner, L.B. Wood, L.R. Wroe
Affiliation(s) Greater London Council
England

Publication or Journal of the Water Pollution Control Federation
Publisher

Publication Date: January 1977 Volume/Issue/Report No.: 49(1):103-110

Summary: Paper presents a detailed review of the massive Greater London combined sewer system. System is one of oldest in use today and has developed largely through experience. Present-day system is capable of handling typical 5-hour, "once in five years" storm without overflow. London has extensive automated monitoring network in existence since 1966. Special techniques were developed to handle sampling of gravity sewers discharging through tide gates to the Thames (due to backwater and river water intrusion problems). Combination of 5-year design storm with antecedent DO's leads to once in 10 to 15 year lethal DO levels. Approach used for control calls for storage and treatment, using in-line, available unused canals and "water meadow" storage. Even brief detention results in significant physical treatment. Modeling and real-time control of system out of question, because of complexity of system. Some in-stream reaeration under consideration.

Reviewed by: C. Beckers

Date: May 23, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 5

CATEGORY: P,L,R

Title Non-Point Sources and Planning for Water Pollution Control

Author(s) W. Whipple, Jr. and J.V. Hunter
Affiliation(s) Rutgers University
New Brunswick, NJ

Publication or Journal of the Water Pollution Control Federation
Publisher

Publication Date: January 1977 Volume/Issue/Report No.: 49(1):15-23

Summary: General review of non-point source pollution. Summarizes status, some available data and some existing programs. Reiterates Enviro Control contention that runoff accounts for at least as much pollution as point sources. Cites a number of studies showing BOD and phosphorus loadings for agricultural, suburban and urban conditions. Shows distinct seasonal variability in BOD for various runoff discharges. Contends that nutrient loads, particularly phosphorus, are not adequately represented by low-flow data. Shows strong relationship of heavy metals to particulates, giving stronger sediment metals loads than in water column. Suggests "drainage area management" as single most important element to control. Is somewhat pessimistic about existing institutions providing adequate "drainage area management". Notes strong need for disinfection of stormwater. Contends DO levels in streams can be maintained more cheaply by oxygenation than by treating runoff.

Reviewed by: C. Beckers

Date: May 24, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 6

CATEGORY: P

Title Planning for Implementation under Section 208.

Author(s)	W.C. Lienesch	G.A. Emison
Affiliation(s)	USEPA	Planning Council
	Washington, DC	Montgomery County, MD

Publication or Publisher	Journal of the Water Resources Planning and Management Division, ASCE
--------------------------	---

Publication Date: November 1976 Volume/Issue/Report No.: 102 (WR2) : 283-295

Summary: Excellent review of 4 major problem areas in the implementation of 208 plans: constraints of existing capital investments in treatment, low probability of consistent application of non-structural approaches, legal barriers to successful designation of a management agency, and limitations on positive citizen participation. EPA has made a policy decision to allow 201 plans to go ahead without 208 input; this adds on new coordinative requirement that may preclude adaptations of certain non-structural approaches. The concept of cost-effectiveness used to evaluate both structural and non-structural alternatives must be expanded to include social, political and economic impacts. There is a bias in operating agencies toward facilities and little coordination between operating and planning agencies. The major barrier to land use controls is political, especially due to fragmentation of governmental authority and the influence of growth-oriented developers. This probably requires state controls. The Act contains nine requirements for the authority of the designated agency. In most states, these authorities are fragmented among 6 or more different organizations. Even selections of a single lead agency may be difficult. This has been alleviated somewhat by belated recognition by EPA of the role of states in 208 planning. In the area of citizen participation the basic problem is one of awkwardness of large committees. Also, an over-reliance of planners on technical analysis leads to distrust by those not schooled in the methods. There is some concern that citizen participation may extend to court suits that will be counter-productive, no matter what the outcome. The 2-year limit is seen as a fundamental readblock to resolution of many of these issues.

Reviewed by: C. Beckers

Date: 24 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 7

CATEGORY: E

Title Hydraulics of Slope Erosion by Overland Flow

Author(s) S. Komura
Affiliation(s) Gifu University
Kagamigahara, Gifu, Japan

Publication or Journal of the Hydraulics Division, ASCE
Publisher

Publication Date: October 1976 Volume/Issue/Report No.: 102(HY10): 1573-1586

Summary: Paper examines problem of computation (estimation) of slope erosion using deterministic (non-statistical) methods. Develops equations for estimating slope erosion from first principals and shows agreement with limited data available. Calls for development of additional study data to give coefficients for broader range of soils, etc.

COASTAL ZONE
INFORMATION CENTER

FEB 1 1978

Reviewed by: C. Beckers

Date: 25 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 8

CATEGORY: E

Title Runoff Files for Flood Hydrograph Simulation

Author(s) A.L. Lumb L.D. James
Affiliation(s) Hydrocomp, Inc. Georgia Inst. of Tech.
Atlanta, GA Atlanta, GA

Publication or Journal of the Hydraulics Division, ASCE
Publisher

Publication Date: October 1976 Volume/Issue/Report No.: 102(HY10):1515-
1531

Summary: Although focusing on flooding, the paper presents concepts that may be found useful in dealing with pollution from stormwater runoff. The approach is to develop a computational scheme that segments the problem into 2 parts, what is leaving the land and how it is transported in the drainage system. Runoff patterns are developed for a variety of soil, slope, rainfall, etc. patterns to be used repeatedly in testing alternative drainage routings. The Stanford Watershed Model is used to create the runoff file and a Hydrocomp-proprietary model for flow routing. Approach is suitable to long term repeated use to test alternatives as they are proposed by government, private owners and developers.

Reviewed by: C. Beckers

Date: 25 May 77

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 9

CATEGORY: L, R

Title Land Use and Water Quality in New York Rivers

Author(s) D.A. Haith
Affiliation(s) Cornell Univ, Ithaca, NY

Publication or Journal of the Environmental Engineering Div., ASCE
Publisher

Publication Date: February 1976 Volume/Issue/Report No.: 102 (EEI): 1-15

Summary: Paper uses statistical methods to analyze relationship between water quality and land uses in New York. Finds significant correlations between nitrogen and land uses. Suspended solids was correlated only with high density residential, while no correlations were found for phosphorus. Regression equations were developed for nitrogen and suspended solids, explaining 89% and 63% of the variance, respectively. Transportation was found to be a useful indicator of commercial/industrial and residential development, explaining more variance than these other factors independently. Nitrogen is negatively related to forests and positively related to cropland, agriculture and transportation. Suspended solids were related most closely to high density residential development. They were not able to separate point and non-point sources within a land use, using this analysis.

Reviewed by: C. Beckers

Date: 25 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 10

CATEGORY: L,R

Title Salt Storage and Runoff in Urban Watershed

Author(s) R.H. Hawkins
Affiliation(s) Utah State Univ.
Logan, Utah

Publication or Journal of the Environmental Engineering Division,
Publisher ASCE

Publication Date: August 1976 Volume/Issue/Report No.: 102(E4):737-
743

Summary: Brief paper indicates 82% of salt applied to highways in study area is carried away in runoff (annual averages). This indicates 18% either is deposited or leaves by other means. Study shows increasing summer chlorides. Contents in base flow indicating build-up of salt deposits affecting groundwater chlorides. Paper cites other research showing fraction in runoff ranging from 50% to 100% (+).

Reviewed by: C. Beckers

Date: 25 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 11

CATEGORY: E, M, T

Title Theory of Storage and Treatment-Plant Overflows

Author(s) C.D.D. Howard
Affiliation(s) Consultant
Winnipeg, Canada

Publication or Journal of Environmental Engineering Division ,ASCE
Publisher

Publication Date: August 1976 Volume/Issue/Report No.: 102(EE4):709-
722

Summary: Excellent paper presenting the theoretical basis and some demonstration for a stochastic model of a storage and treatment system for stormwater runoff. Basic inputs to the analysis are weather records and estimates of drainage basin characteristics. These are used to estimate statistical parameters descriptive of the interaction among a sequence of rainfalls, available storage, treatment capacity and expected overflow. Method is somewhat biased to represent heavy rainfalls better than light rainfalls. Looks like good approach to consider when dealing with specific site problem; not appropriate to gross area-wide planning.

Reviewed by: C. Beckers

Date: 25 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 12

CATEGORY: P

Title Executive Summary of Section 208 Program for Designated
Areas - Federal Water Pollution Control Act Amendments of
1972

Author(s)

Affiliation(s) US Environmental Protection Agency
Washington, DC 20460

Publication or (Same)
Publisher

Publication Date: October 1974 Volume/Issue/Report No.: PB-258 163

Summary: Concise summary of 208 Program as of October 1974.
Slightly out of date with regard to designation/non-designation
policy, but otherwise a good overview of important aspects of
program.

Reviewed by: C. Beckers

Date: 23 May 77

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 13

CATEGORY: E

Title Water Quality Simulation and Public Law 92-500 -
Case Study: Southwestern Illinois

Author(s) N.V. Schultz A. Wilmarth
Affiliation(s) Hydrocomp, Inc. Southwestern Illinois Metro &
Chicago, IL Regional Planning Commission
Collinsville, IL.

Publication or (Unpublished)
Publisher

Publication Date: ? Volume/Issue/Report No.:

Summary: Paper describes application of Hydrocomp Simulation Program (HSP) to load allocation and alternative selection for SIMAPC. Few details of model, but appears to be standard time-variable water quality model with a hydrological "front-end" to provide runoff data. Point sources are represented in more common "direct input" form. Model appears to be best suited for analysis of non-urban runoff, since it does not seem to have pipe routing capability. (HSP is proprietary to Hydrocomp.) Results are typical of those achievable with other models.

Reviewed by: C. Beckers

Date: 23 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 14

CATEGORY: E

Title Development and Application of a Simplified Stormwater
 Management Model

Author(s) Lager, J.A., T. Didriksson and G.B. Otte
Affiliation(s) Metcalf & Eddy

Publication or EPA Report
Publisher

Publication Date: August 1976 Volume/Issue/Report No.: EPA-600/2-76-218

Summary:

A simplified stormwater management model has been created to provide an inexpensive, flexible tool for planning and preliminary sizing of stormwater facilities.

The model delineates a methodology to be used in the management of stormwater and consists of a series of interrelated tasks that combine small computer programs and hand computations. The model successfully introduces time and probability into stormwater analysis, promotes total system consciousness on the part of the user, and assists in establishing size-effectiveness relationships for facilities.

Advantages of Simplified SWMM for planning applications over SWMM include reduced cost, reduced data requirements and ability to simulate continuous records over long time periods (eg, 20 yrs). Advantages over STORM include ability to allow time steps of one day (as well as one hour), thus reducing computer costs for analysis of long records, and ability to allow a network of sewer channels, overflow points and drainage areas.

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FEB 1 1978

Reviewed by: S.G. Chamberlain, Ph.D.

Date: May 25, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 15

CATEGORY: S, A, I, M, T, R, L, E, P, C

Title Urban Runoff-Quantity and Quality (Proceedings of a
Conference held at Franklin Pierce College, August 11-16,
1974)

Author(s) W. Whipple, Jr. (ed.)

Affiliation(s)

Publication or ASCE

Publisher New York, New York

Publication Date: 1975

Volume/Issue/Report No.:

Summary:

Proceedings of a conference on the state-of-the-art in urban runoff as of 1974. Divided into 6 topics; 1) User needs, 2) Social, political, and economic aspects, 3) Collection, storage and treatment, 4) Environmental impact, 5) Data collection and 6) Flood management. Topics are of varying technical content. Sections on collection, storage, and treatment provide greatest substantive information. Serves to emphasize relationship between flood control and water quality.

Reviewed by: C. Beckers

Date: 14 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 16

CATEGORY: E

Title Water Quality Management Planning for Urban Runoff

Author(s)

Affiliation(s) U. S. Environmental Protection Agency
Office of Water Planning and Standards
Washington, DC 20460

Publication or
Publisher

Publication Date: December 1974 Volume/Issue/Report No.: EPA440/9-75-004

Summary:

Although not identified as such, this is the so-called URS model approach to urban runoff modeling. Three levels of resolution are described, depending on the desired degree of detail and the availability of site-specific data. All computations are manual. The method focuses on impervious areas, but is expandable to include pervious areas as well. The method provides estimates of quantity and quality of runoff for a design storm. Some discussion of available treatment, abatement and disposal methods is included. Methods described are appropriate to Preliminary Evaluation Phase analysis.

Reviewed by: C. Beckers

Date: 14 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 17

CATEGORY: S, A, I, M, T, R, L, E, P, C

Title Urban Stormwater Management and Technology: An Assessment

Author(s) J. A. Lager and W. G. Smith
Affiliation(s) Metcalf & Eddy, Inc.
Palo Alto, California 94303

Publication or USEPA-NERC Cincinnati
Publisher Cincinnati, OH 45268

Publication Date: December 1974 Volume/Issue/Report No.: EPA 670/2-74-040

Summary:

A definitive "textbook" on urban stormwater management reviews the nature of the problem and the various alternatives for control. Approaches considered include: solid waste management, street cleaning, control of chemicals applications, erosion control, sewer separation, I/I control, sewer flushing, regulators, remote monitoring and control, storage, physical treatment, biological treatment, physical-chemical treatment, and disinfection. Other areas detailed include design/implementation approaches (e.g. math models) and O&M factors. An extensive reference list is included. Good companion work to Document Numbers 2 and 3.

Reviewed by: C. Beckers

Date: 14 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 18

CATEGORY S A I M T R L E, P, C

Title Selected Urban Stormwater Runoff Abstracts
July 1971-June 1972

Author(s) D. A. Sandoski
Affiliation(s)

Publication or USEPA-ORM
Publisher Washington, DC 20460

Publication Date: December 1972 Volume/Issue/Report No. EPA-R2-72-127

Summary:

As the title implies, 215 abstracts of technical articles in a variety of international journals on the subject of urban stormwater for the 1971-1972 period. It is one of a series of such annual bibliographies. Predominance of hardware, operating and structural emphasis.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 19

CATEGORY: E

Title Modeling NonPoint Pollution from the Land Surface

Author(s) A. S. Donigan, Jr. and N. H. Crawford
Affiliation(s) Hydrocomp, Inc.
Palo Alto, California 94394

Publication or USEPA-ORM
Publisher ERL-Athens
Athens, Georgia 30601

Publication Date: July 1976 Volume/Issue/Report No.: EPA-600/3-76-083

Summary:

This is the documentation report for the Non Point Source Pollutant Loading (NPS) Model. The model is one of a series of related models including the Agricultural Runoff Model (ARM), and Pesticide Transport Model (PTR) developed under the auspices of the EPA Athens Laboratory. Model is capable of representing water temperature, DO, sediment and up to five user-specified non-point pollutants. Model emphasizes overland, open channel and natural water course flows, giving little consideration to sewerage flow. Appears most useful for simulating gross water quality effects in larger watersheds with a diversity of urban and rural (predominantly rural) land uses. Would be especially useful in examining gross impact of urbanization of a watershed. Model is computerized and level of data inputs are probably most appropriate for detailed study of a single watershed.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 20

CATEGORY: M.R.

Title Erosion and Sedimentation-A Planning Report

Author(s) US Army Corps of Engineers & US Dept. of Agriculture
Affiliation(s) Soil Conservation Service

Publication or New England River Basins Commission
Publisher New Haven, Connecticut 06511

Publication Date: January 1975 Volume/Issue/Report No.:

Summary:

A planning report on coastal and upland soil erosion and sedimentation in the Long Island Sound drainage basins. First 2/3 of report is on coastal erosion; remainder on upland erosion. In the Sound region, soil erosion is considered less severe than in other regions of the country, but still significant. Report summarizes benefits and losses due to sedimentation and erosion. Finds erosion losses highest in untreated croplands, followed by urban areas (due to large urban area). Construction sites account for 3rd largest losses. About 35% of soil loss is attributable to "natural" causes that are not strongly related to man's use. Estimates based on Universal Soil Loss Equations for most areas.

Reviewed by: C. Beckers

Date: 15 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 21

CATEGORY: E

Title Literature Review and Analysis of Techniques for Identification
and Evaluation of Non-Point Sources of Pollutants

Author(s)
Affiliation(s) Dames & Moore

Publication or Greater Portland Council of Governments
Publisher Portland, Maine

Publication Date: January 1976 Volume/Issue/Report No.: 7787-001-86

Summary:

Report is somewhat spotty in its coverage of available techniques, giving 3 pages (for example) to methods for evaluating impact on lakes and ponds without citing any of the several models available. It does, however, provide some useful summaries of 3 computerized data management systems (ADAPT, GIMS, and LUDA), of 5 runoff models (STORM, SWMM, BATTELLE's UWM, PTR, and RRM) and 7 receiving water models (DOSAG, QUAL II, STREAM SSAM, AUTO-QUAL, MONOGAHELA MODEL, and COLEAT)

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 22

CATEGORY: S. A. I. M. T. R. L. E, P, C

Title Proceedings-Urban Stormwater Management Seminars
Atlanta, Georgia Nov. 4-6, 1975 & Denver, Colorado Dec. 2-4,
1975

Author(s)

Affiliation(s)

Publication or USEPA

Publisher Planning Assistance and Policy Branch
Water Planning Division
Washington, DC 20460

Publication Date: Volume/Issue/Report No.: WPD 03-76-04

Summary:

Collection of excellent technical papers presented on all aspects of urban stormwater runoff. Authors are all well known and recognized for their expertise in the field.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 23

CATEGORY: S, A, I, M, T, R, L, E, P, C

Title Urbanization and Sedimentation-A Bibliography
Volume 2

Author(s) US Dept. of the Interior
Affiliation(s) Office of Water Research and Technology
Water Resources Scientific Information Center
Washington, DC 20240
Publication or
Publisher

Publication Date: December 1975 Volume/Issue/Report No.: OWRT/WRISC 75-207

Summary:

Bibliography of journal papers, reports, books, etc
on the effects of urbanization on stream sediment load and
sedimentation.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 24

CATEGORY: R.E.M

Title The Influence of Land Use on Stream Nutrient Levels

Author(s) J. M. Omernik
Affiliation(s) Corvallis ERL
Corvallis, Oregon 97330

Publication or USEPA
Publisher ORD
Corvallis, Oregon 97330

Publication Date January 1976 Volume/Issue/Report No.: EPA-600/3-76-014

Summary:

Studied relationship between basin characteristics, especially land use, and nutrient (nitrogen and phosphorus) levels in streams for 473 basins in eastern US. Reports positive correlation between nutrient levels and agricultural, or combined agricultural and urban land use. Forested areas have lower levels. Found that loads were comparable in all areas, but there were strong differences in concentrations due to differences in hydrology. Regression equations give limited predictive ability. These results are qualitatively similar to those reported in Document Number 9, but not directly comparable due to differences in form of the regression equations.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 25

CATEGORY: C.E

Title Characteristics of Non-Point Source Pollution and
Urban Runoff (Draft)

Author(s) Southeastern Regional Planning and Economic Development
Affiliation(s) District
Marion, Massachusetts 02738

Publication or
Publisher

Publication Date: December 1975 Volume/Issue/Report No.:

Summary:

Report is presented in 2 parts. The first part
summarizes the characteristics and comparative magnitudes
of runoff from the following types of sources:

- agriculture
- sanitary land fills and solid waste
- general soil erosion
- commercial and pleasure boating
- septic systems
- highways
- industries

The second part of the report constitutes a review
and implicit endorsement of the URS method described in
Document Number 16.

Reviewed by: C. Beckers

Date: 15 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 26

CATEGORY: L

Title Impact of High Rise Buildings on the Urban System

Author(s) H.A. Simon (ed.)
Affiliation(s) Illinois Univ. at Chicago
Chicago, Ill.

Publication or National Science Foundation
Publisher Washington, DC

Publication Date: Dec. 1976 Volume/Issue/Report No.: PB-263 387
NSF-GK-41663

Summary :

Describes a university study of political, social, economic, transportation and utilities impacts of high-rise building development. Relevant conclusions are: 1) high-rise development tends to reduce dependence on private automobiles by putting residences in close proximity to central business district and 2) high-rise development allows larger permeable spaces surrounding structures, reducing runoff.

Reviewed by: C. Beckers

Date: 31 May 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 27

CATEGORY: M,T

Title Demonstration of Void Space Storage with Treatment and
 Flow Regulation

Author(s) Karl R. Rohner Associates, Inc.
Affiliation(s) Akron, OH 44321

Publication or USEPA/ORD
Publisher Municipal Environmental Research Lab
 Cincinnati, OH 45268

Publication Date: Dec. 1976 Volume/Issue/Report No.: EPA-600/2-76-272

Summary:

Well written report documents demonstration of a so-called "Geo-Cell" concept for detention of combined sewage for later treatment. A "Geo-Cell" consists of an excavation lined with an impermeable material, filled with a porous medium that provides structural support to a "roof" of natural fill. Incorporated in the system are a clarifier, chlorination and settling tubes, which provide a degree of treatment in addition to the medium itself prior to discharge to the STP. Results of the demonstration were generally positive with recommendations confined to design features rather than overall concept. The "roof" is suitable to open space or parking area development, as it is level with surrounding terrain.

Reviewed by: C. Beckers

Date: 31 May 77

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 28

CATEGORY: C.A.T

Title Proceedings of Workshop on Micro-organisms in Urban
Stormwater - Held at Edison, NJ, on March 24, 1975

Author(s) USEPA/ORD
Affiliation(s) Municipal Environmental Research Laboratory

Edison, NJ 08817
Publication or
Publisher

Publication Date: Nov. 1976 Volume/Issue/Report No.: EPA-600/2-76-244

Summary: Proceedings of a conference to discuss current EPA
research in 3 basic areas:

- 1) How are pathogens related to indicator organisms
(e.g. coliforms) in urban runoff.
- 2) What high-rate disinfection processes might be used
to treat these pathogens.
- 3) What methods should be used to select levels of
disinfection (coliforms are not necessarily the
best criteria).

First paper focuses on evaluation of lab methods. Finds wide
variability in ratios of pathogens to indicators in stormwater;
some inhibition of pathogens by stormwater. Second, paper finds
very high indicator in low-flow waters and poor correlation
between increases in pathogens and in indicators during runoff.
Found chlorine disinfection superior to ozonation. Third, paper
reports early findings on study of viruses in stormwater. Fourth,
paper examines ways of elimination use of Cl for stormwater
disinfection due to high dosage requirements. Finds ClO₂ a good
alternative in both performance and cost.

Reviewed by: C. Beckers

Date: 1 June 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 29

CATEGORY: C, R

Title Effects of Agricultural Practices and Land Disposal of
Solid Waste on Quality of Water from Small Waterbeds

Author(s) C.H. Shelton & G.M. Lessman
Affiliation(s) University of Tennessee
Knoxville, Tenn.

Publication or U.S. Dept. of Agriculture, OWRR
Publisher Washington, DC

Publication Date: Jan. 1977 Volume/Issue/Report No.: PB-263-240

Summary: Brief report summarizes resulting water quality due to agricultural land management practices on a number of test watersheds. Concludes significant increase in contaminants during late winter and early spring when land is fallow and runoff greatest. Increases in nitrates, chlorides and orthophosphates in runoff directly related to fertilizer application. Metals in runoff correlated with rainfall history and fallow conditions. Timing of application of sewage sludge as a fertilizer affects concentrations of coliforms and BOD in runoff. Careful distinction must be made between heavy metals in runoff from natural sources and those due to management practices.

Reviewed by: C. Beckers

Date: 2 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 30

CATEGORY: C,R

Title Investigation to Determine Extent and Nature of Non-Point
Source Enrichment and Hydrology of Several Recreational
Lakes of Eastern Washington.

Author(s) H.D. Copp, et al.
Affiliation(s) Washington State University
Pullman, Washington

Publication or
Publisher US Dept. of Interior OWRR
Washington, DC

Publication Date: Nov. 1976 Volume/Issue/Report No.: PB 263 354

Summary: A detailed study of the specific effects of increasing
human use of previously virgin lakes in hilly regions of
Washington State.

Reviewed by: C. Beckers

Date: 2 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 31

CATEGORY: _____

Title Attitudes and Interactions of Citizen Advisory Groups
 & Governmental Officials in the Water Resources Planning
 Process.

Author(s) R.A. Shanley
Affiliation(s) Univ. of Massachusetts
 Amherst, Mass.

Publication or U.S. Dept. of Interior/OWRT
Publisher Washington, DC

Publication Date: August 1976 Volume/Issue/Report No.: PB 263 483

Summary: The report studies use of citizen participation in three
 New England area environmental planning studies. It raises
 specific questions as to the representativeness of the groups
 and the inputs elicited through them. Specific communications
 limitations are identified, both between the general populace
 and the group, and between the group and the planners.

Reviewed by: C. Beckers

Date: 2 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 32

CATEGORY: P

Title Case Study of the Metropolitan Council as an
Environmental Management Organization

Author(s) School of Public Affairs
Affiliation(s) University of Minnesota
Minneapolis, MN

Publication or USEPA
Publisher Washington, DC

Publication Date: Jan. 1976 Volume/Issue/Report No.: PB-263 486

Summary:

This report looks ahead to the requirements of unified, multi-media control of pollutants by a single regional agency. By an accident of its history, the Minneapolis-St. Paul (Minnesota) Metropolitan Council has many of the attributes of such an agency, including operational, governmental, planning, funding and regulatory functions. In some ways, it constitutes a "super-government", although it has no authority to override any local government. The report traces the historical development of the Council as an example of the problems entailed in the creation of such an agency.

FEB 1 1978

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Reviewed by: C. Beckers

Date: 22 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 33

CATEGORY: L, C

Title Nitrate in Effluents from Irrigated Lands, Annual Report

Author(s) P.E. Pratt, et al.
Affiliation(s) University of California
Riverside, CA

Publication or NSF-RANN
Publisher Washington, DC 20550

Publication Date: July 1976 Volume/Issue/Report No.: NSF/RA-760285

Summary:

The conclusions of several other documents reviewed are that nutrients in runoff from agricultural areas is strongly dependent on antecedant conditions of water flux and fertilizer application (e.g. Document Number 29). This collection of papers reports on detailed research into the movement of nutrients, specifically nitrates, into, within, and out of the "field system". Focus of work is irrigated fields, but work may be extendable. The approach is at a level that limits the immediate application of the results to runoff modeling, but they may be useful for specific study cases.

Reviewed by: C. Beckers

Date: June 16, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 34

CATEGORY: C, R

Title Characterization of Urban Runoff - New Jersey

Author(s) W. Whipple, J.V. Hunter, and S.L. Yu
Affiliation(s) Rutgers University
 New Brunswick, NJ

Publication or OWRT
Publisher Dept. of the Interior
 Washington, DC

Publication Date: June 1976 Volume/Issue/Report No.: PB 261246

Summary:

Reports on a detailed field sampling program to characterize urban runoff in New Jersey. The program is one of several such funded to sample urban runoff in eastern states. Pollutants considered include heavy metals, BOD, phosphates and suspended solids. Dry weather, wet weather and storm event sampling was done on both stream and sewer flows. A limited attempt was made to relate the results to land use in qualitative terms. Results should be useful in assigning load rates for urban areas in Rhode Island, due to geographic proximity and climatological similarity.

Reviewed by: C. Beckers

Date: June 16, 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 35

CATEGORY: M, E, C, P

Title Some Consequences of Area Wide Runoff Control Strategies
 in Urban Watersheds

Author(s) R.A. Hardt and S.J. Burges
Affiliation(s) University of Washington
 Seattle, Washington

Publication or OWRT
Publisher Dept. of the Interior
 Washington, DC

Publication Date: June 1976 Volume/Issue/Report No.: PB 261258

Summary:

A numerical model of stormwater runoff is used to examine the consequences of alternative hydraulic controls on hypothetical urban watersheds. No consideration is given to quality aspects. The approach is to attempt to devise strategies that maintain peak flows at the pre-urbanized level for the watershed. Conclusions include:

- controls must be on watershed, not political jurisdiction, basis
- choice of optimum controls requires detailed hydrologic data
- runoff volume reduction is effective control method
- restricted outflow achieves peak control, but extends time of outflow
- longer duration storms created higher peaks than shorter duration storms.

Reviewed by: C. Beckers

Date: June 16, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 36
CATEGORY: M, T, E, R, P

Title Analysis of Stormwater Seepage Basins in
 Florida

Author(s) H. Rubin, J.P. Glass, and A.A. Hunt
Affiliation(s) University of Florida
Gainesville, FL

Publication or
Publisher OWRT
Dept. of the Interior
Washington, DC

Publication Date: Sept. 1976 Volume/Issue/Report No.: PB 261393

Summary :

Study is directed at providing a design approach for engineering stormwater basins to serve multiple purposes of flood control, stormwater pollution abatement and groundwater recharge. Of particular concern is transport of stormwater pollutants into the groundwater. An overall approach is developed incorporating traditional preliminary evaluations and final design steps, but emphasizing recent developments in legal, institutional, economic and social considerations. A thorough analysis of flow from a basin into groundwater is presented, based on first principals. Particular attention is paid to conditions of high groundwater (a problem not unknown in Rhode Island). A substantial portion of the paper is devoted to analysis of the Floridan Aquifer, which does not appear to be especially relevant to Rhode Island.

Reviewed by: C. Beckers Date: June 16, 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 37

CATEGORY: E,P

Title Utility of Urban Runoff Modeling - Proceedings of a
 Special Session, Spring Annual Meeting, AGU, April 14, 1976.

Author(s) ASCE
Affiliation(s) New York, New York

Publication or OWRT
Publisher Dept. of the Interior
 Washington, DC

Publication Date: July 1976 Volume/Issue/Report No.: PB 261460

Summary:

Proceedings of a workshop session on the cost-effectiveness of use of models in planning and engineering for urban runoff. Identifies reasons for poor acceptance of modeling by most public agencies, including lack of motivating pressures, prior failures of models and conservatism of consultants. Models believed most useful for examining alternate futures, for understanding the details of a complex problem and especially for design of active sewer control systems. The greatest problem identified is lack of calibration data, due primarily to lack of foresight on part of funding agencies. Stormwater models apparently cannot be justified on the basis of capital savings, but rather on effectiveness of the resulting design, especially in a tax or fine based incentive system. The papers describe a number of successes in application of models to urban runoff.

Reviewed by: C. Beckers

Date: June 17, 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 38

CATEGORY: S.I.C.A

Title Sampling and Analysis of Stormwater Runoff from Urban and Semi-Urban/Rural Watersheds

Author(s) F.T.R. McElroy, C.F. Mattox, D.W. Hartmann, J.M. Bell
Affiliation(s) Perdue University
W. Lafayette, Indiana

Publication or OWRT
Publisher Washington, D.C.

Publication Date Sept. 1976 Volume/Issue/Report No.: PB262080

Summary: Deals solely with stormwater runoff, not combined sewage. Presents a useful review of literature for BOD, suspended solids, fecal coliforms and effects of first flush. Notes some difficulties with BOD test at low dilutions. One study cited related virtually all fecal coliform in stormwater runoff to non-human sources. Some researchers observe "first flush", others relate concentration only to rainfall intensity. Some researchers show little relationship between concentration and antecedent conditions. Actual research consists of a detailed study of 1 urban and 1 rural watershed. Sampling station design is thoroughly described, including automatic instrumentation. Emphasizes need for automated sample initiation to catch first samples. BOD's, suspended solids and fecal coliform analysis were performed. Sampling was done by continuous sequential compositing to make up the necessary analysis volume. Results show need for high frequency sampling to get good peak values. Mass of pollutants washed off was directly related to volume of flow, so observation of 90% of mass required observation of 90% of flow. This sets sampling duration. Concentration of pollutants in "dry weather" flow were found to be higher in urban area than in rural. Report tabulates detailed results from a number of storms at both sites. Urban hydrograph and pollutographs are clearly "peakier" than rural. Urban area clearly yielded higher BOD values, with the urban area average about 4-5 times greater than the rural area. While the average suspended solids were similar in both basins, the urban area showed greater variability. The maximum suspended solids was 1.5-2 times greater in the urban area. However, the load per acre is greater for the rural area than for the urban area.

Reviewed by: C. Beckers

Date: 29 June 77

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 39

CATEGORY: E

Title Methods for Calculating Maximum Flood Discharges for
Natural Watercourses and Urban Areas in the USSR

Author(s) V.V. Kuprianov
Affiliation(s) State Hydrological Institute
Leningrad, USSR

Publication or NSF
Publisher Washington, D.C.

Publication Date August 1976 Volume/Issue/Report No.: PB262070

Summary: Brief report on stormwater quantity analysis practices
in the Soviet Union. Emphasis is on a highly statistical
approach to determination of coefficients in the classical
"rational method". (One of a series; see Document Number 40 and 41.)

Reviewed by: C. Beckers

Date: 29 June 77

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 40

CATEGORY: E, I

Title Urban Hydrological Modeling and Catchment Research
 in the United Kingdom

Author(s) M.J. Lowing
Affiliation(s) Institute of Hydrology
 Wallingford, Oxon, U.K.

Publication or NSF
Publisher Washington, DC

Publication Date: July 1976 Volume/Issue/Report No.: PB 262 069

Summary:

Brief report summarizes work in progress in the United Kingdom but provides virtually no technical data on that work.

(One of a series; see Document Numbers 39 and 41.)

Reviewed by: C. Beckers

Date: 29 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 41

CATEGORY: E, I, S

Title Urban Hydrological Modeling and Catchment Research
 in Canada

Author(s) J. Marsalek
Affiliation(s) Canada Centre for Inland Waters
 Burlington, Ontario, Canada

Publication or NSF
Publisher Washington, DC

Publication Date: June 1976 Volume/Issue/Report No.: PB 262 068

Summary:

Notes difficulties in instrumenting catchments, particularly sewer flow gaging, and high costs. Primarily a summary of work in progress on urban runoff with few technical details. Does provide some guide on parameters typically sampled. Block diagrams of some existing automated data systems. Ranges of values given for many parameters, but insufficient information to relate them to land use. Reviews a number of existing, available models including SWMM and STORM. Gives brief description of an attempt to combine best features of SWMM and STORM. Provides details on a sensitivity analysis of SWMM. An appendix provides details on a number of individual catchment studies. (One of a series of reports; see Document Numbers 39 and 40.)

Reviewed by: C. Beckers

Date: 29 June 1977

Title **Methods for Separation of Sediment from Storm Water at Construction Sites**

Author(s) J.F. Ripken, J.M. Killen, J.S. Gulliver
Affiliation(s) Univ. of Minnesota
Minneapolis, Minnesota
USEPA
Publication or Municipal Environmental Research Lab
Publisher Cincinnati, Ohio

Publication Date: Jan. 1977 Volume/Issue/Report No.: EPA-600/2-
77-033

Summary:

Report focuses on treatment of sediment load that results even after application of best management practices during construction. Assumes problem is primarily suspended mineral solids, not dissolved or organic materials. Points out that construction should not be held accountable for natural sediment removal, typically 1-4 tons/acre/year in U.S. Simple settling basin is most cost-effective in removing coarse fractions. This also has the effect of reducing the flow to any high-rate removal facility, reducing capital costs at that point. Uses "rational formula" and "Universal Soil Loss" equation to estimate sediment loads. Use of commercial clarifiers is not deemed economical; much better to use traditional settling basin with commercial secondary systems. Report goes through a detailed evaluation of commercially available secondary units of the following types:

- sieve bends (not suitable)
- rotary screens
- tubular strainers
- micro-strainers (consider for larger size sediments)
- disc strainers
- high rate gravity separators (useful to reduce settling basin size)
- hydrocyclones (no additional capability over settling basins)
- swirl concentrators (no additional capability over settling basins)
- teacup separators
- centrifuges (not cost-effective)
- filtration (not suitable, except sand or rotary vacuum)
- electrophoresis (not suitable)

Also considered are chemical additives to promote coagulation and flocculation, which are considered useful to attended operations.

Reviewed by: C. BeckersDate: 29 June 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 43

CATEGORY: C

Title Projection of Petroleum Content of Urban Runoff

Author(s) W. Whipple, Jr., J.V. Hunter, S.L. Yu
Affiliation(s) Rutgers University
 New Brunswick, NJ

Publication or NSF
Publisher Washington, DC

Publication Date: April 1975 Volume/Issue/Report No.: PB 262 756

Summary:

Study of a single 318 acre storm drainage basin in Philadelphia indicates urban runoff will contribute more petroleum to the Delaware River than the 7 refineries on the river after installation of secondary treatment. Drainage basin is well-maintained multi-family residential/commercial/industrial. Low-flow petroleum concentrations found negligible. Petroleum was associated primarily with suspended sediments; little floating petroleum was observed. Enclosure 1 gives concentrations of various petroleum components.

Reviewed by: C. Beckers

Date: July 1, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 44

CATEGORY: S,A,I,M,T,R,L,E,P,C

Title Urban Runoff Pollution Control Technology Overview

Author(s) R. Field, A.N. Tafuri, H.E. Masters
Affiliation(s) EPA-MERL
Edison, NJ

Publication or USEPA-ORD
Publisher Cincinnati, Ohio

Publication Date: March 1977 Volume/Issue/Report No.: EPA-600/2-77-047

Summary:

Reviews on-going and completed EPA programs in urban runoff and cites some results. Gives typical concentrations and loads for urban runoff. Identifies a computerized data base containing screened data for model development; may be useful to 208. Categorizes urban water management analysis into 4 levels, according to availability of data and sophistication of methodology. Level 1 (desk top) approaches mentioned the Univ. of Florida method and the Hydrosience method. Significantly, the URS method is not mentioned. Various structural and non-structural alternatives are reviewed; indicates storage probably most cost-effective structural method.

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FEB 1 1978

Reviewed by: C. Beckers

Date: 1 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 45

CATEGORY: C

Title Sediment Discharge from an Area of Highway Construction,
 Appleman's Run Basin, Columbia County, Pennsylvania

Author(s) D.A.V. Eckhardt
Affiliation(s) USGS
 Harrisburg, PA

Publication or USGS
Publisher Harrisburg, PA

Publication Date: October 1976 Volume/Issue/Report No.: PB 263 616

Summary:

Brief report on detailed study of effects of highway construction on sediment in stream. Found $\approx 100\%$ increase in sediment yield due to construction on about 10% of basin. Most (83%) of erosion occurred during January to June storms, with 69% between April to June. After completion of construction, restorative measures took several years to become effective. The report presents storm by storm data for stream discharge and sediment yield, but not rainfall.

Reviewed by: C. Beckers

Date: 5 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 46
CATEGORY: M, T, E, C

Title Pollutational Analysis of Combined Sewer Systems

Author(s) O.G. Lindholm
Affiliation(s) Norwegian Inst. for Water Research
 Blinden, Norway

Publication or Journal of the Environmental Engineering Div.
Publisher ASCE

Publication Date: April 1976 Volume/Issue/Report No.: 102(EE2): 301-312

Summary:

Paper uses math models to examine hypothetical catchment/treatment plant combinations for their effectiveness in reducing the pollution reaching the receiving waters. Basic control and treatment system studied includes storage, primary settling, aeration and secondary settling (with return sludge to the aeration tank). (NOTE: system is assumed combined.) Paper cites a number of references to BOD₅ in stormwater and uses 4 basic curves to represent time-variation of BOD in runoff. Of particular interest are graphs showing effect of runoff BOD on total discharge as a function of storage and sanitary waste strength, effect of storage volume on BOD discharged and relationship among choice of storage, overflow and clarifier size. Concludes that retention, in combination with properly sized overflows and clarifier, can substantially reduce discharge of pollution.

Reviewed by: C. Beckers Date: June 20, 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 47

CATEGORY: P,C

Title Non-Point Sources of Pollution: A Federal Perspective

Author(s) M.A. Pisano
Affiliation(s) U.S. EPA
 Washington, DC

Publication or Journal of the Environmental Engineering Div.,
Publisher ASCE

Publication Date: June 1976 Volume/Issue/Report No.: 102 (EE3): 555-565

Summary:

Paper is basically a renewed "call to arms" in the non-point area. It cites numerous nationwide statistics to emphasize the magnitude of the problem and proposes specific inter-governmental programs to resolve it. One interesting proposal is creation of a CCC-like, labor intensive work program to reduce pollutant collection in sewers, highways, etc., thereby reducing "first-flush". Emphasis of the paper is on rural, agricultural, silvacultural, mining, etc., rather than urban.

Reviewed by: C. Beckers

Date: June 20, 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 48

CATEGORY: M

Title Equalization of Flow Variations in Combined Sewers

Author(s) L. E. Janson, S. Bendizen and A. Harlaut
Affiliation(s) Stockholm, Sweden

Publication or Journal of the Environmental Engineering Div.,
Publisher ASCE

Publication Date Dec. 1976 Volume/Issue/Report No.: 102(EE6): 1139-1149

Summary:

Paper describes the design principles behind a unique passive device for use of available storage in sewer systems to reduce combined sewer overflows. The helical shaped device operates on the principle of a weir, but has features that preserve flow at dry weather and enhance passage of suspended materials at high flow. It is capable of correct metering at all flows, through full-pipe. At full-pipe, the discharge through the device is virtually the same as for no-control, i.e. friction losses are negligible. It can be installed in existing sewers and there are no moving parts. Used in tandem, these devices can substantially increase the storage available in a system.

Reviewed by: C. Beckers

Date: 20 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 49

CATEGORY: T.R.C

Title Stormwater Studies and Alternatives in Atlanta

Author(s) R.F. Holbrook, A.J. Perez, B.G. Turner & H.J. Miller
Affiliation(s) Black, Crow & Eidsness, Inc. Jordan, Jones & Goulding,
Atlanta, Georgia Inc.
Atlanta, Georgia

Publication or Journal of Environmental Engineering Div., ASCE
Publisher

Publication Date: December 1976 Volume/Issue/Report No.: 102(E6):1277 1263-

Summary: Paper summarizes results of a Corps of Engineers funded urban runoff study in the Atlanta area. Provides data on typical stormwater pollutant loadings. Finds correlation between flow and loading, but no "first flush" phenomenon in storm sewer. Phosphorus loads were found independent of land development. Samples in "downtown" area tended to have higher concentrations than suburban samples. "First flush" was found in combined sewers. Corps of Engineers STORM model was used to forecast loads; notes limitations of STORM handling short-term hydrographs. Changed STORM to calculate BOD separately, rather than as ratio to suspended solids. Found difficulty transferring data from one watershed to another with similar land uses. Attempted to use a steady-state model for receiving waters, using "small" storm. Found forecast water quality well below standards. Found chemical treatment of stormwater best, due to high dissolved loads. When considering storage, found above- and below-ground had similar capital costs but below-ground maintenance costs were 10-20 times greater. For combined sewer overflows, recommends a hybrid of storage with either air flotation or transmission to a treatment facility.

Found following cost-effectiveness ratios:

Separation \$3.62/lb. BODs removed
Storage & air flotation \$0.86/lb. BODs removed
Storage & treat \$0.93/lb. BODs removed

Provides good tabular data on costs. (Paper also noted difficulties with BOD tests at low dilutions.)

Reviewed by: C. Beckers

Date: 29 June 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 50

CATEGORY: S,A,I,C

Title A Study of Runoff from Small Rural Watersheds in Response
 to Completed and Proposed Land Use Changes

Author(s) M.J. Smith
Affiliation(s) Ohio State University
 Columbus, Ohio

Publication or OWRT
Publisher Washington, DC

Publication Date: 1972

Volume/Issue/Report No.: PB 264 900

Summary:

An M.S. thesis on the results of land use changes in 2 rural watersheds. In one, the results of strip-mining are studied; in the other, the anticipated results in a change in agricultural practices are considered. Extensive use is made of statistical models. Data were collected starting in 1968. Emphasis is on hydrologic effects, but water quality is also considered.

Reviewed by: C. Beckers

Date: 5 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 51

CATEGORY: E

Title Wastewater Storage - Simulation of Instream Effects

Author(s) J.S. Tapp
Affiliation(s) USEPA, Region IV
 Atlanta, GA

Publication or Journal of the Environmental Engineering Division
Publisher ASCE

Publication Date: Dec 1976 102(EE6):
 Volume/Issue/Report No.: 1151-1159

Summary:

Paper concludes that storage of point source wastes during low flow and discharge during high flows is a viable mechanism for maintaining stream standards. While the paper is directed at point sources, it is related to stormwater runoff storage problems and computation of stream assimilative capacity under high flow conditions. Approach makes use of steady-state modeling, which limits application to seasonal high flows, not individual storms. It also assumes that the increased flows do not increase the pollutional concentrations, a weak assumption under stormwater runoff conditions.

Reviewed by: C. Beckers

Date: 6 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 52

CATEGORY: E.C.

Title Nonpoint Source Pollution from Agricultural Runoff

Author(s) D.A. Haith J.V. Dougherty
Affiliation(s) Cornell University Gannett, Fleming, Corddry
Ithaca, NY and Carpenter Engrs.
Harrisburg, PA
Publication or Journal of Environmental Engineering Div., ASCE
Publisher

Publication Date: October 1976 Volume/Issue/Report No.: 102(EE5):1069 1055-

Summary:

Report describes the theory and demonstration of a model for agricultural runoff intended for use with typically available data. Emphasis is placed on failure of model to include snowmelt, which has been shown significant. Model is applied to an agricultural basin of New York's Southern Tier, with satisfactory results. Comparison is made between a wet year and a dry year. Also compares detailed model with estimation techniques, finding the detailed model gives consistently lower loadings. Finds the gross estimation techniques unsatisfactory for water quality management, because they are insensitive to local factors.

Reviewed by: C. Beckers

Date: 8 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 53

CATEGORY: E,M

Title Design Efficiency of Stormwater Detention Basins

Author(s) D.C. Curtis and R.H. McCuen
Affiliation(s) Univ. of Maryland
 College Park, MD

Publication or Journal of the Water Resources Planning and
Publisher Management Division, ASCE

Publication Date: May 1977 Volume/Issue/Report No.: 103(WR1): 125-140

Summary:

Reports on theory and initial results of a simple computer model for stormwater detention basins. The model incorporates hydrologic and sediment components and considers the effects of various outflow structures. Results of use of the model on a typical case indicate location of the detention within the basin can have a significant effect on peak discharge, even increasing it if timing is right. Also confirms the assumption of Document Number 42 that detention is most effective on the larger particle sizes. Finds shallower basins more effective than deeper ones and use of initial storage is not an effective mechanism from the viewpoint of either flow or sediment control.

Reviewed by: C. Beckers

Date: 8 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 54

CATEGORY: E

Title Urban Runoff Digital Computer Model

Author(s) S. Phamwon and Y.S. Fok

Affiliation(s) Khon Kaen Univ.
Khon Kaen, Thailand

University of Hawaii
Honolulu, Hawaii

Publication or Publisher Journal of Hydraulics Division ASCE

Publication Date: July, 1977 Volume/Issue/Report No.: 103(HY7):735⁷²³⁻

Summary:

Paper describes the development of yet another hydraulic urban watershed model. Comparison with the ILLUDAS model shows equivalent results at lower rainfalls and better results at higher rainfalls.

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Reviewed by: C. Beckers

Date: 3 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 55

CATEGORY: E

Title Water Quality Impacts of Urbanization- A Methodology

Author(s) K.F. Jalal
Affiliation(s) James F. Maclaren, Ltd.
Toronto, Canada

Publication or Journal of the Environmental Engineering Div, ASCE
Publisher

Publication Date: February 1977 Volume/Issue/Report No.: 103(EEL):49-57

Summary:

Brief paper describes a quantitative methodology for use of the STORM model in preliminary design of urban stormwater management systems. The central feature of the method is a pollutant loading index that compares the results of urbanization with acceptable results. (The approach violates the basic principles of US water quality standards, as discussed in Raytheon's report on Quantitative Methods for Preliminary Design of Water Quality Surveillance Systems.)

Reviewed by: C. Beckers

Date: 8 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 56

CATEGORY: P

Title Appraisal of Areawide Wastewater Planning

Author(s) R.P. Shubinski and W.N. Fitch
Affiliation(s) Water Resources Engineers
 Springfield, VA

Publication or Journal of the Water Resources Planning and
Publisher Management Division, ASCE

Publication Date: May 1977 Volume/Issue/Report No.: 103(WR1): 63-72

Summary:

Paper compares the relationships among 208, 201, 303 and 402 planning as intended in PL 92-500 with the actuality as realized under EPA administration. Identifies a number of actual relationships, none of which correspond with that intended in the law. Four technical limitations to the success of 208's are: insufficient data base, inadequate analysis techniques, manpower shortages and limited understanding of side-effects. Management limitations are claimed to be failure to identify public goals, jurisdictional conflicts, economic conflicts, ineptness of public officials and restricting institutional structures.

Reviewed by: C. Beckers

Date: 8 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 57

CATEGORY: E,M

Title Optimal Storage Control in a Combined Sewer System

Author(s) B.H. Bradford
Affiliation(s) Georgia Institute of Technology
 Atlanta, GA

Publication or Journal of the Water Resources Planning and
Publisher Management Division, ASCE

Publication Date: May 1977 Volume/Issue/Report No.: 103(WR1):1-15

Summary:

Demonstration of a previously published hierarchical control technique for combined sewer systems. The paper compares the results of automated control with static control methods, such as weirs, and shows automated control to be much more effective in terms of flood reduction, pass through to treatment and minimization of both storage use and overflows. The method is a hierarchical solution to the control problem using linear programming and significantly reduces the computational requirements over that necessary for a global solution.

Reviewed by: C. Beckers

Date: 8 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 58

CATEGORY: P

Title Urban Sediment Problems: A Statement on Scope, Research,
Legislation and Education

Author(s) Task Committee on Urban Sedimentation
Affiliation(s) ASCE

Publication or Journal of the Hydraulics Division, ASCE
Publisher

Publication Date: April 1975 Volume/Issue/Report No.: 101(HY4): 329-340

Summary :

The paper is a product of the task committee review of the state of knowledge on urban sedimentation. It indicates that, while this sediment source is small relative to non-urban sources, it frequently has more effect due to the population densities in urban areas. The paper summarizes available control guidelines, outlines areas of research, investigates needed legislation and suggests educational goals.

Reviewed by: C. Beckers

Date: 8 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 59

CATEGORY: P

Title Comprehensive Water Quality Management Planning

Author(s)	K.A. Bartel	L.V. Gutierrez
Affiliation(s)	Dept. of Environmental Resources Harrisburg, PA	Camp Dresser & McKee Boston, MA
Publication or Publisher	Journal of the Hydraulics Division, ASCE	

Publication Date: April 1975 Volume/Issue/Report No.: 101(HY4): 371-386

Summary:

The paper describes the Pennsylvania COWAMP program, which is a pre-208 comprehensive water quality management plan. Emphasis of the paper is on the management and organization of COWAMP, rather than the technical results.

Reviewed by: C. Beckers

Date: 8 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 60

CATEGORY: E, M

Title Detention Storage Control Strategy Development

Author(s)	H.G. Wenzel	J.W. Labadie & N.S. Grigg
Affiliation(s)	Univ. of Illinois Urbana, IL	Colorado State University Fort Collins, Colorado

Publication or Journal of the Water Resources Planning and
Publisher Management Division, ASCE

Publication Date: **April 1976** Volume/Issue/Report No.: **117-135** 102(WR1):

Summary :

The paper provides a detailed analysis of control strategies for storage/treatment of stormwater runoff. Demonstration case is Vicente Basin in San Francisco, with 5 detention basins. Analysis is restricted to quantity of overflow. A relatively simple runoff model is coupled with a computerized optimization routine to identify preferred control strategies based on a 66 year rainfall record. The report concludes that control leads to substantial improvement over no control. Also concludes that the single most important parameter in selecting the strategy is the maximum allowable flow to the interceptor. Points to storm prediction as a major requirement for a true test of the concept. Indicates that a dynamic control strategy may be better than a static one.

Reviewed by: C. Beckers Date: 11 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 61

CATEGORY: E

Title Routing Stormwater Through a Drainage System

Author(s) S. Pinkayan
Affiliation(s) Asian Institute of Technology
 Bangkok, Thailand

Publication or Journal of Hydraulics Division, ASCE
Publisher

Publication Date: Jan 1972 Volume/Issue/Report No.: 98(HY1): 123-135

Summary:

Theoretical paper reporting the results of analysis of storm drains using method of characteristics to solve the equations. Method allows calculation of hydrograph at any point in the drain on surface profile at any time.

Reviewed by: C. Beckers

Date: 11 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 62

CATEGORY: E

Title Synthesis of Snowmelt Runoff Hydrographs

Author(s) A.B. Cunningham
Affiliation(s) Univ. of Nevada
 Reno, Nevada

Publication or Journal of the Hydraulic Division, ASCE
Publisher

Publication Date: Jan 1977 Volume/Issue/Report No.: 103(HY1): 51-67

Summary:

Author develops a method for preparing a dimensionless snowmelt hydrograph specific for each given basin. Using limited data for a single observed event the method allows development of a characteristic hydrograph that can then be used in general for the basin. Input to the analysis are air temperatures and water equivalent of the snow pack. Method is shown to give reasonable results for forested areas, but is probably not very good in inhabited areas, especially urban areas.

Reviewed by: C. Beckers

Date: 11 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 63

CATEGORY: E

Title: Peak Discharge Frequency from Rainfall Information

Author(s) W.C. Hughes
Affiliation(s) Univ. of Colorado
Denver, Colorado

Publication or Journal of Hydraulics Div. ASCE
Publisher

Publication Date: Jan. 1977 Volume/Issue/Report No. 103(HY1):39-50

Summary: Paper proposes and demonstrates a probabilistic method for determining hydrograph shape from hyetograph data. It is intended for use on small basins having little hydrologic data available, but having rainfall data. The demonstration case gives satisfactory results, but the author calls for more extensive testing to validate method.

Reviewed by: C. Beckers

Date: 12 July 77



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 64

CATEGORY: R. T

Title: Impact on Marine Benthos of Wastewater Discharge

Author(s) G.T. Orlob and D.A. O'Leary
Affiliation(s) Resource Mgmt. Assoc. Lowry and Associates
Lafayette, Calif. San Diego, Calif.

Publication or
Publisher Journal of the Environmental Engineering Div.,
ASCE

Publication Date: April 1977 Volume/Issue/Report No.: 103(E2):307-320

Summary: The paper reviews the data on benthic conditions surrounding the San Diego ocean outfall off Pt. Loma. The survey has been underway since 1962, one year prior to beginning the discharge from the 80 MGD design capacity plant. The plant is now hydraulically overloaded, treating 110 MGD. The outfall continues to meet all water quality standards, including water contact sports. While sediment BOD's have increased, there is no apparent detrimental effect on benthic organisms. There are, however, community adjustments to the outfall. The environment appears capable of continued discharge to the site 2 miles offshore.

Reviewed by: C. Beckers

Date: 12 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 65

CATEGORY: E, T

Title: Management Model for Wastewater Disposal on Land

Author(s) A. Koenig & D.P. Loucks
Affiliation(s) Cornell Univ.
Ithaca, NY

Publication or
Publisher Journal of the Environmental Engineering Div.,
ASCE

Publication Date: April 1977 Volume/Issue/Report No.: 103(E2):181-
196

Summary: The paper proposes a model incorporating the gross performance of a storage lagoon and soil disposal area in removing nitrogen from wastewater. Nitrogen is the limiting constituent, due to its mobility in the soil system, compared with other constituents. The fundamental constraint is the drinking water standard for nitrate-N (10 mg/l). The management objective is satisfied by minimizing cost through minimizing area. A sample problem is given, demonstrating the method.

Reviewed by: C. Beckers

Date: 12 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 66

CATEGORY: S,A,I,M,T,R,L,E,P,C

Title : Areawide Assessment Procedures Manual

Author(s) Municipal Environmental Research Lab.
Affiliation(s) USEPA-ORD
Cincinnati, OH

Publication or USEPA
Publisher Washington, DC

Publication Date: July 1976 Volume/Issue/Report No. EPA-600/9-76-014

Summary: This three volume manual is under a condition of continuing growth and development. It is intended to ultimately provide guidance for all aspects of 208 planning. At present it consists of two partially complete loose-leaf volumes covering many of the technical aspects of the problem. Some of the sections prepared by private consultants display a distinct bias in favor of the approaches developed by those consultants to the exclusion of others. It is probably not an especially useful document for this reason.

Reviewed by: C. Beckers

Date: 12 July 1977



RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 67

CATEGORY: E.C.I.

Title: Storm Water Management Modeler

Author(s) H.C. Torno, Ed.
Affiliation(s)

Publication or USEPA-ORD
Publisher Washington, DC

Publication Date: June 1977 Volume/Issue/Report No.: --

Summary: Proceedings of the SWMM User's Group meeting at
Gainesville, FL. on 4-5 April 1977.

Includes following papers:

"Simulation Studies for Section 208, PL 92-500"
A.M. Lumb, Hydrocomp, Inc., Atlanta, GA.

"Interfacing STORM/SWMM"
J. Kuhner Meta Systems Inc, Cambridge, MA

"Continuous Unsteady Simulation with QQS"
W.F. Geiger, Dorch Consult, Munich, Germany

"SWMM/STORM Application in Canada"
A.R. Perks, Proctor & Redfern LTD, Toronto

"Non-Structural Best Management Practises for Control of Combined
Sewer Problems"
W.C. Pisano, Energy & Environmental Analysis, Inc., Boston, MA

"Criteria for Using Models"
M.B. Sounen, WRE, Inc., Walnut Creek, CA.

Reviewed by: C. Beckers

Date: 12 July 1977

RAYTHEON

RI 208 PROJECT
URBAN RUNOFF TASK
DOCUMENT SUMMARY FORM

DOCUMENT NUMBER: 68

CATEGORY: E

Title Storm Water Management Model: Level I. Preliminary
Screening Procedures.

Author(s) J.P. Heaney, W.C. Huber, S.J. Nix
Affiliation(s) University of Florida
Gainesville, Florida

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Summary: The report documents a stormwater analysis procedure that is significantly less detailed than the original SWMM. The objective is to provide a rough, order-of-magnitude estimate of the impact of stormwater runoff, using desk top procedures. While the approach is not widely tested, the authors are recognized for their competence in the field, leading the reviewer to expect a useful methodology.

Reviewed by: C. Beckers

Date: 25 July 77

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SECTION 11

GLOSSARY

abatement: The lessening of pollution effects.

acre foot: A unit for measuring the volume of water. It is equal to the amount of water needed to cover one acre of land with water one foot deep.

the act: Public Law 92-500. "Federal Water Pollution Control Act Amendments of 1972".

advanced waste treatment: A further degree of treatment of wastewater, over and above so-called secondary treatment, in order to further purify these effluent waters by the removal of additional amounts or types of pollutants, or their modification into non-polluting forms.

aerated lagoon: A natural or artificial wastewater treatment lagoon (generally from 4 to 12 feet deep) in which mechanical or diffused air aeration is used to supplement the oxygen supply.

aeration: The act of exposing to the action of air, such as, to mix or charge with air.

aerosol: A suspension of fine solid or liquid particles in air or gas.

agricultural land: Land in farms regularly used for agricultural production. The term includes all land devoted to crop or livestock enterprises; for example, the farmstead lands, drainage and irrigation ditches, water supply, cropland, and grazing land of every kind in farms.

agronomic practices: The soil and crop activities employed in the production of farm crops, such as selecting seed, seedbed preparation, fertilizing, liming, manuring, seeding, cultivation, harvesting, curing, crop sequence, crop rotations, cover crops, stripcropping, pasture development, etc.

algae: Any of numerous chlorophyll-containing plants of the phylum thallophyta that grow in either sea water or fresh water; seaweeds and pond scum are algae.

algorithm: A rule or procedure for solving a logical or mathematical problem, frequently as incorporated into computer programs.

alkaline: Having the qualities of a base; i.e., a pH above 7.0.

alluvium: Clay, silt, sand, gravel, or other rock materials transported by flowing water and deposited in comparatively recent geologic time as sorted or semi-sorted sediments in riverbeds, estuaries, floodplains, and in fans at the base of mountain slopes.

ammonia-nitrogen (HN_4): A form of nitrogen which is an essential nutrient to plants (can cause algal blooms if all nutrients are present in sufficient quantities). A product of natural decomposition of fecal matter, urea and other animal protein.

ammonification: The biochemical process whereby ammonia-nitrogen is released from nitrogen-containing organic compounds.

ammonium fixation: The adsorption or absorption of ammonium ions by the mineral or organic fractions of the soil in a manner that they are relatively unexchangeable by the usual methods of cation exchange.

antecedent conditions: Initial conditions in catchment as determined from hydrologic events prior to storm.

antecedent moisture conditions (AMC): The degree of wetness of a watershed at the beginning of a storm.

antecedent precipitation index (API): An indicator of the amount of water (in inches) present in the soil at any given time. The calculation of the API is based on the assumption that, during time periods of no precipitation, the soil moisture decreases logarithmically with time.

aquifer: Any geological formation that contains water, especially one that supplies wells and springs.

area rainfall distribution factor: The ratio of the rainfall in a selected area to that measured at a reference rainfall gage.

artificial recharge: The addition of water to the groundwater reservoir by activities of man, such as irrigation or induced infiltration from streams, wells, or spreading basins.

asphalt concrete: A paving material consisting of aggregate bound with asphalt, made by heating both materials to around 300°F, followed by mixing, delivering, spreading, and compacting while still hot.

attenuation: The reduction of the magnitude of an event, as the reduction and spreading out of the impact of storm effects.

available nutrient: That portion of any element or compound in the soil that readily can be absorbed and assimilated by growing plants.

average cleansing efficiency: The percent of deposited solids removed from a given length of sewer.

background: A description of pollutant levels arising from natural sources, and not because of man's immediate activities.

backwater curve: The longitudinal shape of the water surface in a stream or open conduit where such water surface is raised above its normal level by a natural or artificial constriction or a change in grade.

base flow: Stream discharge derived from groundwater sources. Sometimes considered to include flows from regulated lakes or reservoirs. Fluctuates much less than storm runoff.

baseline sample: A sample collected during dry-weather flow (i.e., it does not consist of runoff from a specific precipitation event).

basin: The term "basin" means the streams, rivers, tributaries, and lakes and the total land and surface water area contained in one of the major or minor basins defined by EPA, or any other basin unit as agreed upon by the state(s) and the Regional Administrator.

beneficial use of water: The use of water for any purpose from which benefits are derived, such as domestic, irrigation, industrial supply, power development, or recreation.

benthic deposits: deposits of living, bottom dwelling organisms in a stream.

best available technology (BAT): "Not later than July 1, 1983, effluent limitations for categories and classes of point sources, other than publicly owned treatment works, ... shall require application of the best available technology economically achievable for such category or class, which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants as determined in accordance with regulations issued by the Administrator pursuant to Section 304(b)(2) of this Act...." (Act, Section 301(b)(2)(A)).

best practicable control technology (BPCT): "Not later than July 1, 1977, effluent limitations for point sources, other than publicly owned treatment works, shall require the application of the best practicable control technology currently available as defined by the Administrator pursuant to Section (304(b) of this Act..." (Act, Section 301(b)(1)(A)). This is also referred to as Best Practical Technology (BPT).

best practicable waste treatment technology (BPWTT): "Waste treatment management plans and practices shall provide for the application of the best practicable waste treatment technology before any discharge into receiving waters, including reclaiming and recycling of water and confined disposal of pollutants so they will not migrate to cause water or other environmental pollution..." (Act, Section 201(b)).

BOD₅: Five-day Biochemical Oxygen Demand: A standard test for the amount of oxygen utilized in aerobic decomposition of a waste material during a five-day incubation at a specified constant temperature.

biological treatment processes: Means of treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Trickling filters, activated sludge processes, and lagoons are examples.

brackish water: Water containing dissolved minerals in excess of acceptable normal municipal, domestic, and irrigation standards, but less than that of sea water.

buffer strips: Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

bypass: A pipe line which diverts wastewater flows away from or around, pumping or treatment facilities - or bypasses them - in order to limit the flows delivered to such facilities and prevent surcharging or adversely affecting their operation or performance.

calibration: The procedure of assigning values to the uncertain or unknown parameters in simulation model and adjusting them until model predictions correspond acceptably closely with observed prototype behavior.

catch basin: A chamber or well, usually built at the curb line of a street, for the admission of surface water to a sewer or sub-drain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.

catchment: Surface drainage area.

channel: An elemental one-dimensional flow path having the usual properties of a water channel, which is used to construct certain receiving water simulation models. Also used in discussing the river channel itself.

check dam: Small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel scour, and promote deposition of sediment.

chemical oxygen demand (COD): A standard test which measures the total quantity of oxygen required for oxidation of organic (carbonaceous) matter to carbon dioxide and water using a strong oxidizing agent (dichromate) under acid conditions.

chemical weathering: Chemical reactions such as hydrolysis, or oxidation, by which rocks and minerals are broken down into soil.

clay: The smallest mineral particles in soil, less than .004 mm in diameter; soil that contains at least 40 percent clay particles, less than 45 percent sand, and less than 40 percent silt.

clay seal: A barrier constructed of impermeable clay that stops the flow of water.

clear cutting: The felling of all trees in an area at one time.

closed basin: A basin is considered closed with respect to surface flow if its topography prevents the occurrence of visible outflow. It is closed hydrologically if neither surface nor underground outflow can occur.

coliform bacteria: All the aerobic and facultative anaerobic, gram-negative nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C. Used as an indicator of bacterial pollution.

collector sewer: A sewer located in the public way which collects the wastewaters discharged through building sewers and conducts such flows into larger interceptor sewers and pumping and treatment works. (Referred to also as "street sewer").

combined sewer: A sewer receiving both surface runoff and sewage.

commercial forest: The forest which is both available and suitable for growing continuous crops or raw logs or other industrial timber products, judged capable of growing at least 20 ft³ of timber per acre per year.

complete sewer separation: separation of all public combined sewers into two separate and independent sewer systems, one for the handling of sanitary sewage and industrial and commercial wastes and the other for the handling of storm water flow.

concentration: The quantity of a given constituent in a unit volume or weight of water.

confined aquifer: An aquifer which is bounded above and below by formations of impermeable or relatively impermeable material.

conservation: The protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

consumptive use (Water): The sum of the quantity of water used by vegetative growth in transpiration or building of plant tissue and the quantity evaporated from adjacent soil or plant surfaces in a given specified time. Also referred to as Evapotranspiration.

contamination: The degradation of natural water quality as a result of man's activities, to the extent that its usefulness is impaired.

contour furrows: Furrows plowed approximately on the contour on pasture or rangeland to prevent soil loss and increase infiltration. Also, furrows laid out approximately on the contour for irrigation purposes.

conventional tillage: Land prepared by turning with a mold-board plow, disking, harrowing and cultivation of row crops.

cover crop: A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of regular crop production or between trees and vines in orchards and vineyards.

critical depth: The depth of water flowing in an open channel or partially filled conduit corresponding to one of the recognized critical velocities.

curb length: The distance of single street curb, or the length of one side of a street or other thoroughfare. Distinguished from street-length which normally represents two or more curb lengths.

degree days: Sum of negative departures of average daily temperature from 65°F; used to determine demand for fuel for heating purposes and snow melt calculations.

demineralization: The process of reducing the concentration or removing the mineral salts from water.

denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

depletion (Ground Water): The withdrawal of water from a groundwater source at a rate greater than its rate of replenishment, usually over an extended period of several years.

depression storage: Watershed capacity to retain water in puddles, ditches, depressions and on foliage.

design storm: A selected rainfall pattern of specified amount, intensity, duration, and frequency which is used as a design basis.

desilting area: An area of grass, shrubs, or other vegetation used for inducing deposition of silt and other debris from flowing water, located above a stock tank, pond, field, or other area needing protection from sediment accumulation.

detention dam: A dam constructed for the purpose of temporary storage of streamflow or surface runoff and for releasing the stored water at controlled rates.

detention: The slowing, dampening, or attenuating of flows either entering the sewer system or within the sewer system by temporarily holding the water on a surface area, in a storage basin, or within the sewer itself.

digestion: The anaerobic or aerobic decomposition of organic matter resulting in partial gasification, liquefaction, and mineralization.

dilution ratio: The ratio of the quantity of combined sewer overflow or storm sewer discharge to the average quantity of diluting water available after initial mixing at the point of disposal or at any point under consideration. This is not only used with respect to sewer overflows but also it is used for any point or nonpoint sources of pollution.

direct connection: Any opening, pipe, or other arrangement permitting storm water to directly enter a sanitary sewer.

directly connected paved area: The paved portion of a basin from which runoff water can reach a sewer without first passing over grassed area.

direct runoff: The water that enters stream channels during a storm or soon after. It may consist of rainfall on the stream surface, surface runoff, and seepage of infiltrated water.

disinfection: The art of killing the larger portion of micro-organisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

dispersion: The mixing of polluted fluids with a large volume of water in a stream, estuary, or other body of water.

dispersion, soil: The breaking down of soil aggregates into individual particles, resulting in single-grain structure. Ease of dispersion is an important factor influencing the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is.

dissolved solids (DS): The total amount of dissolved material, organic and inorganic, contained in solution in water or wastes.

distributed load: A constituent load which enters the receiving water over a considerable distance, as in the case of groundwater seepage, rather than at a point as with a sewer outfall.

DO: Dissolved oxygen, the amount of gaseous oxygen dissolved in a liquid sample.

DO deficit: The extent by which the dissolved oxygen concentration falls below its saturation level.

drainability: ability of the soil system to accept and transmit water by infiltration and percolation.

drainage basin: A geographical area or region which is so sloped and contoured that surface runoff from streams and other natural watercourses is carried away by a single drainage system by gravity to a common outlet or outlets; also referred to as a watershed or drainage area.

drainage density: Ratio of the total length of all drainage channels in a drainage basin to the area of that basin.

dry weather flow: The combination of sanitary sewage, and industrial and commercial wastes normally found in the sanitary sewers during the dry weather season of the year. Also that flow in streams during dry seasons.

ecosystem: A total organic community in a defined area or time frame.

effluent limited segments: "Any segment where it is known that water quality is meeting and will continue to meet applicable water quality standards or where there is adequate demonstration that water quality will meet applicable water quality standards after the application of the effluent limitations required by Sections 301(b)(1)(A) and 301(b)(1)(B) of the Act". (40 CFR 130.11(d)(2)).

effluent limitation: "The term 'effluent limitation' means any restriction established by a State or the Administrator on quantities, rates, and concentrations or chemical, physical, bio-

logical, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance." (Act, sec. 502 (11)).

effluent standard: A restriction on the quantities or concentrations of constituents from an effluent source.

emissions: Effluents discharged into the environment, specified as weight per unit time for a given pollutant from a given source.

entry time: The time in minutes for runoff water to flow from the most remote point on the directly connected paved area to a specified inlet.

equalization: The averaging (or method for averaging) of variations in flow and composition of a liquid.

equivalent days of accumulation (EDA): A measure of the relative days of accumulation of pollutants on a street surface as a function of rainfall and sweeping history and respective removal efficiencies.

equivalent uniform depth (E.U.D.): The average amount of rainfall over an area developed from the constituent rain gage stations and their associated Thiessen Polygons contained within the network of gaging stations.

erosion, sheet: The removal of a fairly uniform layer of soil from the land surface by runoff water.

estuary: The mouth of a river, where tidal effects are evident and where fresh water and sea water mix.

eutrophication: The progressive enrichment of surface waters particularly non-flowing bodies of water such as lakes and ponds, with dissolved nutrients, such as phosphorous and nitrogen compounds, which accelerate the growth of algae and higher forms of plant life and result in the utilization of the usable oxygen content of the waters at the expense of other aquatic life forms.

evapotranspiration: The comined processes of evaporation from land, water and other surfaces, and transpiration by plants.

fecal coliform: Fecal coliform are indicators of human and animal pollution and are expressed as numbers of bacteria per volume of sample.

feedlot: A relatively small, confined land area for raising and fattening cattle.

filter strip: Strip of permanent vegetation above farm ponds, diversion terraces, and other structures to retard flow of runoff water, causing deposition of transported material, thereby reducing sediment flow.

first flush: The condition, often occurring in storm sewer discharges and combined sewer overflows, in which a disproportionately high polluttional load is carried in the first portion of the discharge or overflow.

floatable trap: A device or structural configuration which intercepts floatable solids and retains these materials at a desired location until removed and disposed of by predetermined means.

flooding: A method of surface application of water which includes border strip, contour check, and spreading methods.

floodplain: The flat ground along a stream course which is covered by water at flood stage.

food chain: Refers to the dependence for food of organisms upon each other in a series, beginning with plants and ending with the largest carnivores.

food web: The combination of all of the food chains in a community.

flow augmentation: The addition of water or wastewater effluents to surface water sources, for the purpose of increasing the volume of such water as rivers, lakes or other inland bodies of surface water; in the case of groundwater, the addition of wastewater effluents which will increase the volume of the underground water source and raise or help maintain the groundwater table.

foundation drain: A pipe or series of pipes which collects groundwater from the foundation or footing of structures and discharges these waters into sanitary, combined or storm sewers, or to other points of disposal, for the purpose of draining unwanted waters away from such structures.

frequency of storm (Design Storm Frequency): The anticipated period in years which will elapse, based on average probability of storms in the design region, before a storm of a given intensity and/or total volume will recur; thus a 10-year storm can be expected to occur on the average once every 10 years. Sewers designed to handle flows which occur under such storm conditions would be expected to be surcharged by any storms of greater amount or intensity.

grade stabilization structure: A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further head-cutting or lowering of the channel grade.

grassed waterway: A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.

grease: In sewage, grease includes fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and other nonfatty materials. Substances soluble in n-hexane.

grit: Heavier and larger solids which, because of their size and specific gravity, settle more readily to the floor of a swirl concentrator chamber by the phenomenon of gravity classification.

ground water infiltration: The seepage of groundwater into an opening in a sewer.

ground water basin: A ground water reservoir together with all the overlying land surface and the underlying aquifers that contribute water to the reservoir. In some cases, the boundaries of successively deeper aquifers may differ in a way that creates difficulty in defining the limits of the basin.

ground water recharge: Inflow to a ground water reservoir.

ground water reservoir: An aquifer or aquifer system in which ground water is stored. The water may be placed in the aquifer by artificial or natural means.

ground water storage capacity: The reservoir space contained in a given volume of deposits. Under optimum conditions of use, the useable ground water storage capacity volume of water that can be alternately extracted and replaced in the deposit, within specified economic limitations.

groundwater table: The free surface of the groundwater, that surface subject to atmospheric pressure under the ground, generally rising and falling with the season, the rate of withdrawal, the rate of restoration, and other conditions. It is seldom static.

gully: A channel or miniature valley cut by concentrated runoff but through which water commonly flows only during and immediately after heavy rains or during the melting of snow.

gully control planting: The planting of forage, legume, or woody plant seeds, seedlings, cuttings, or transplants in gullies to establish or reestablish a vegetative cover adequate to control runoff and erosion.

hardness: A property of water caused by the presence of calcium and magnesium, which is reflected in the amount of soap necessary to form suds and incrustations in appliances and pipes when the water is heated. It is expressed as an equivalent amount of calcium carbonate.

hard water: Water with over 60 mg/l of hardness.

heavy metals: Metallic elements with high molecular weights, generally toxic in low concentrations to plant and animal life. Examples are: mercury, chromium, cadmium, arsenic, and lead.

herbicide: A chemical substance used for killing plants, especially weeds.

homogenous: Consisting throughout of identical or closely similar material whose proportions and properties do not vary.

humus: That more or less stable fraction of the soil organic matter remaining after the major portion of added plant and animal residues have decomposed; usually amorphous and dark colored.

hyetograph: An intensity-time graph for rainfall derived from direct measurements.

hydrograph: A flow versus time graph derived from direct measurement.

hydrological: Pertains to the branch of hydrology that treats surface and groundwater; its occurrence and movements; its replenishment and depletion; the properties of rocks which control groundwater movement and storage; and the methods of investigation and utilization of groundwater.

hydrologic cycle: The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

hydrology: The science dealing with water in the atmosphere, on the earth's surface, and underground; its properties, laws, geographical distribution, etc.

illicit connection: An unauthorized connection from a residence, apartment, etc., which introduces liquid other than sewage (usually stormwater) into the sanitary sewer.

impervious: Not permitting penetration or passage (e.g., of water).

indirect runoff: That portion of runoff that contributes to the runoff pollution that enters receiving water as point discharges from separate storm sewer systems and as general surface runoff.

industrial waste: The liquid wastes from industrial processes as distinct from domestic or sanitary sewage.

infiltration: The water entering a sewer system, including sewer service connections, from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, and manhole walls. Infiltration does not include, and is distinguished from, inflow. Infiltration includes all extraneous water during wet weather, i.e., groundwater and surface water.

infiltration inflow: A combination of infiltration and inflow waste water volumes in sewer lines that permits no distinction between the two basic sources and has the same effect of usurping the capacities of sewer systems and other sewerage system facilities.

infiltration-percolation: An approach to land application in which large volumes of wastewater are applied to the land, infiltrate the surface, and percolate through the soil pores.

infiltration rate: A soil characteristic determining or describing the maximum rate at which water can enter the soil under specified conditions, including the presence of an excess of water.

inflow: The water discharged into a sewer system, including service connections, from such sources as, but not limited to, roof leaders, cellar, yard and area drains, cooling water dischargers, drains, foundation drains, drains from spring and swampy area, manhole covers, cross connections from storm sewers and combined sewers, catch basin, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

interceptor sewer: A sewer which receives dry-weather flows from a combined collection sewer system and pre-determined additional amounts of storm flow by means of any form of regulating device and then conducts these flows to point by treatment or discharge.

intercepted surface runoff: That portion of surface runoff that enters a sewer, either storm or combined, directly through catch basins, inlets, etc.

irrigation return flow: Irrigation water which is not consumed in evaporation or plant growth, and which returns to a surface stream or groundwater reservoir.

lagoon: A shallow pond, usually man-made, to treat municipal or industrial wastewater.

land application: The discharge of wastewaters onto land areas, as an alternative treatment procedure to conventional method or disposal of effluents into surface water sources.

land cost: Cost of land acquisition including surveys, condemnation proceedings, fees, taxes, leases, and other financial and legal actions.

land use: Differentiating the spatial arrangements and activity patterns of land areas.

land use controls: Methods for regulating the uses to which a given land areas may be put, including such things as zoning, subdivision regulation, and flood-plain regulation.

lateral sewer: A sewer which receives wastes only from the house connections.

leaching: The removal of chemical or physical components from soil or other media by dissolution or physical adsorption action of percolating water.

leachate: The liquid that has percolated through the soil or other media and has extracted dissolved or suspended materials from it.

limited body contact recreation: Use of natural waters, such as rivers, lakes, and coastal water, for recreational purposes which do not represent deliberate or planned total body immersion such as swimming or bathing; thus, use of waters for boating, fishing, and related sports.

main sewer: A sewer to which one or more branch sewers are tributary which serves a large territory; also called a trunk sewer.

mechanical practices: Those management techniques for soil and water conservation that primarily change the surface of the land or that store, convey, regulate, or dispose of runoff water without excessive erosion.

mineralization: The process of accumulation of mineral elements and/or compounds in soil or water.

mulching: The addition of materials (usually organic) to the land surface to curtail erosion or retain soil moisture.

natural erosion: Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man.

natural leaching: The removal by a solvent of the more soluble minerals in soil or rocks by percolating waters.

nitrate (NO_3): A form of nitrogen which is an essential nutrient to plants (can cause algal blooms if all other nutrients are present in sufficient quantities). Product of bacteria oxidation of other forms of nitrogen, from the atmosphere during electrical storms and from fertilizer manufacturing.

nitrification: The biological oxidation of ammonium salts to nitrites and the further oxidation of nitrites to nitrates.

nitrogen (ammonia): A product of microbiologic activity sometimes accepted as evidence of sanitary pollution in surface waters.

nitrogen, available: Usually ammonium, nitrite, and nitrate ions, and certain simple amines are available for plant growth. A small fraction of organic or total nitrogen in the soil is available at any time.

nonpoint source pollution: A pollutant which enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances.

nonsewered urban runoff: Surface runoff in an urban drainage areas which drains into a receiving stream without passing through a sewer system.

nutrient: A substance necessary for the growth and reproductions of organisms.

nutrient, available: The portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

**COASTAL ZONE
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FEB 1 1978

- organic nitrogen: Nitrogen combined in organic molecules such as protein, amines, and amino acids. Gradually converted to ammonia-nitrogen and to nitrites and nitrates if aerobic conditions prevail.
- outfall: The point, location, or structure where wastewater or drainage discharges from a sewer to a receiving body of water.
- overflow: A pipe line or conduit device, together with an outlet pipe that provides for the discharge of portions of combined sewer flows into receiving waters or other points of disposal, after a regulator device has allowed the portion of the flow which can be handled by interceptor sewer lines and pumping and treatment facilities to be carried by and to such water pollution control structures.
- overland flow irrigation: A process of land application of wastewater which provides spray distribution onto gently sloping soil of relatively impervious nature, such as clays, for the purpose of attaining aerobic bio-treatment of the exposed flow in contact with ground cover vegetation, followed by the collection of runoff waters in intercepting ditches or channels and the return of the wastewater back to the spray system or its discharge into receiving waters; sometimes called spray runoff.
- oxidation pond: A basin for the retention of wastewater, on a batch or continuous flow basis, where organic materials can undergo aerobic stabilization in the presence of adequate oxygen made available by either natural or various mechanical means of aeration and mixing.
- partial separation: Removal of some portion of all the elements of storm drainage into a combined sewer; e.g., streets and parking areas only, leaving roof and foundation drainage to enter the combined sewer.
- pathogen: A microorganism capable of causing disease.
- percolation: The movement of water beneath the ground surface both vertically and horizontally, but above the groundwater table.
- pervious: Allowing movement of water.
- pesticides: Chemical compounds used for the control of undesirable plants, animals, or insects. The term includes insecticides, herbicides, algacides, rodent poisons, nematode poisons, fungicides, and growth regulators.
- phosphorus, available: Inorganic phosphorus which is readily available for plant growth.

photogrammetry: The science of making surveys and maps through the use of photographs.

physical-chemical treatment: A method of semi-advanced or advanced wastewater treatment which combines the use of chemicals, such as activated carbon or lime, to induce reactions such as coagulation, absorption or adsorption of pollutorial substances, with processes which physically remove unwanted contaminants by such means as straining, screening, settling, or filtering.

planning process: Strategy for directing resources, establishing priorities, scheduling actions, and reporting programs toward achievement of program objectives.

plume: An area of contaminated water originating from a point source and influenced by such factors as the local water flow pattern, density of pollutant, and characteristics of the dissimilar streams.

point source: "The term 'point source' means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." (Act, Section 502(14)).

pollutant: "The term 'pollutant' means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water." (Act, Section 502(6)).

pollution parameters: The physical, chemical, and bacterial contaminants which can be quantified to indicate pollution levels.

pollutograph: A graph of pollutant concentration as a function of time during a rainfall/runoff event.

polychlorinated biphenyls (PCB): Organochlorine compounds of a pesticidal nature which are usually used for industrial purposes (such as plastic manufacture).

porous pavement: A pavement through which water can flow at significant rates.

pretreatment: The removal of material such as gross solids, grit, grease, and scum from sewage flows prior to physical, biological, or physical-chemical treatment processes to improve treatability. Pretreatment may include screening, grit removal, skimming, preaeration, and flocculation.

primary treatment: Processes or methods, that serve as the first stage treatment of sewage and other wastes intended for the removal of suspended and settleable solids by gravity sedimentation; provides no changes in dissolved and colloidal matter in the sewage or wastes flows.

raw sewage sludge: The accumulated suspended and settleable solids of sewage deposited in tanks or basin mixed with water to form a semi-liquid mass.

reaeration: The process entraining air in liquids such as wastewater effluents, etc. Reaeration is proportional to the dissolved oxygen deficit; its rate will increase with increasing deficit.

recharge basin: A basin provided to increase infiltration for the purpose of replenishing ground water supply.

regulator: A structure installed in a canal, conduit, or channel to control the flow of water or wastewater at intake, or to control the water level in a canal, channel, or treatment unit. In the context of combined sewers, a regulator is a device or apparatus for controlling the quantity and quality of mixtures of sewage and storm water admitted from a combined sewer collector sewer into an interceptor sewer or pumping or treatment facility, thereby determining the amount and quality of the flows discharged through an overflow device to receiving waters, or to retention or treatment facilities.

residential density: The number of persons per unit of residential land area. Net density includes only occupied land. Gross density includes unoccupied portions of residential areas, such as roads and open space.

residual wastes: Those solid, liquid, or sludge substances from man's activities in the urban, agricultural, mining and industrial environment which are not discharged to water after collection and necessary treatment.

retention: The storage of stormwater to prevent it from entering the sewer system: may be temporary or permanent.

return flow: That part of a diverted flow which is not consumptively used and which returns to a source of supply (surface or underground).

riparian rights: A principle of common law which requires that any user of waters adjoining or flowing through his lands must so use and protect them that he will enable his neighbor to utilize the same waters undiminished in quantity and undefiled in quality.

riprap: rough stone of various sizes placed compactly or irregularly to prevent erosion.

roof leader: A drain or pipe that conducts storm water from the roof of a structure, downward and thence into a sewer for removal from the property, or onto or into the ground for runoff or seepage disposal.

routing: Storing, regulating, diverting or otherwise controlling the peak flows of wastewater through a collection system according to some prearranged plan.

runoff: That portion of the precipitation on a drainage area that is discharged from the area in stream channels.

salinity: Salt content concentration of dissolved mineral salts in water or soil.

salinization: The process of accumulation of soluble salts in soil or water.

salt water intrusion: The invasion of a body of fresh water by salt water. It can occur either in surface or groundwater bodies.

sanitary sewer: A sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with minor quantities of ground, storm, and surface waters that are not admitted intentionally.

scour: The clearing and digging action of flowing air or water, especially the downward erosion by stream water in sweeping away mud and silt on the outside of a curve or during a flood.

secchi disk: A disk, painted in four quadrants of alternating black and white, which is lowered into a body of water. The measured depth at which the disk is no longer visible from the surface is a measure of relative transparency.

secondary treatment: Processes or methods for the supplemental treatment of sewage and other wastes, usually following primary treatment, to effect additional improvement in the quality of the treatment wastes by biological means of various types, including activated sludge treatment or trickling filter treatment; designed to remove or modify organic matter. Treatment of wastewater which meets the standards set forth in 40 CFR 133.

sedimentation: The process of subsidence and deposition of suspended matter carried by water, sewage, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material.

separate sanitary sewer: A sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants and institutions, together with minor quantities of ground, storm and surface waters that are not admitted unintentionally.

separate storm sewer: A sewer that carries storm water and surface waters, street wash and other wash waters, or drainage, but excludes domestic wastewater and industrial wastes.

sewer-use ordinance: A regulation, code, or ordinance enacted by a jurisdiction to specify the types and volumes of waste waters that can be discharged into sewer system, the waste waters that cannot be so discharged, and the fees or charges to be imposed for the privilege of discharging those wastes and volumes which are permitted.

sludge digestion: A process by which organic or volatile matter in sludge is gasified, liquefied, mineralized, or converted into more stable organic matter through the activities of living organisms.

sluice gate: A vertically sliding gate of any shape used to control or shut off flow in a sewer or other channel.

SMSA: Except in the New England states, a standard metropolitan statistical area is a county or group of contiguous counties which contain at least one city of 50,000 inhabitants. In the New England states, SMSA's consist of towns and cities instead of counties.

soft water: Water containing 60 mg/l or less of hardness.

spray irrigation: The application of wastewater to land areas by means of stationary or moving sprays which distribute the liquid in sheet, particle or aerosol mist form.

stabilized grade: The slope of a channel at which neither erosion nor deposition occurs.

standard methods: Methods of analysis of water sewage and sludge approved by a Joint Committee by the American Public Health Association, American Water Works Association, and Federation of Sewage Works Association.

storm frequency: The time interval between major storms of predetermined intensity and volumes of runoff for which storm sewers and combined sewers, and such appurtenant structures as swirl concentrator chambers, are designed and constructed to handle hydraulically without surcharging and backflooding: e.g., a five-year, ten-year or twenty-year storm.

storm sewer: A sewer which carries storm water and surface water, street wash and other wash waters or drainage, but excludes sewage and industrial wastes. (Also called a Storm Drain).

storm water infiltration: The entrance of stormwater into a sanitary sewer.

subarea: A subdivision of a subcatchment (generally based upon a single land use but may be identical to a subcatchment).

sub-basin: A physical division of a larger basin which is associated with one reach of the storm drainage system.

subcatchment: A subdivision of a drainage basin (generally determined by topography and pipe network configuration).

subdrain: A pervious backfilled trench containing a pipe or stone for the purpose of intercepting groundwater or seepage.

surface runoff: Precipitation that falls onto the surfaces of roofs, streets, ground, etc., and is not absorbed or retained by that surface, thereby collecting and running off.

terrace: An embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

tertiary treatment: A third stage of treatment of sewage and other wastes, following primary and secondary treatment, for the purpose of further improving the quality of the treated waters by the removal or modification of constituents which have not been removed or modified by previous treatment steps.

topography: General term to include characteristics of the ground surface such as plains, hills, mountains; degree of relief, steepness of slopes, and other physiographic features.

total dissolved solids: The dissolved salt loading in surface and subsurface waters.

total solids: The solids in water, sewage, or other liquids. It includes the dissolved, filterable, and nonfilterable solids.

toxic metals: Any metal substances in wastewater which could be toxic or poisonous to grasses, to crops, or to groundwater, and which could adversely affect those who ingest or imbibe these substances; common examples of toxic metals are copper, cadmium and boron.

transpiration: The process by which plants of all types of agricultural, horticultural and silvicultural growths dissipate water or moisture into the atmosphere from stomata of leaves or other surfaces, in the form of a vapor; dissipation of water by direct evaporation from the surface of plants, bark or other membranes, stomata, and lenticula into the atmosphere.

ultimate oxygen demand: The total amount of oxygen that is utilized by bacteria in the decomposition of sewage. This includes both the carbonaceous BOD and nitrogenous BOD.

uncontrolled storage: Storage not controlled by any remotely operated gates but depending entirely on weir or river elevations.

underdrain system: A system of pipes or ducts, placed underground, to intercept and collect percolated wastewater and to return these waters to a predetermined location for a predetermined purpose, often to prevent the discharge of such underground water into water sources which it is intended to protect.

universal soil loss equation: Predicts the short-term rates of soil loss for localized areas. This equation takes into account the influence of the total rainfall energy for a specific area rather than rainfall amount.

urbanized area: Central city, or cities, and surrounding closely settled territory. Central city (cities) have population of 50,000 or more. Peripheral areas with population density of 1,000 persons per acre or more are included.

urban runoff: Surface runoff from an urban drainage area that reaches a stream or other body of water or a sewer.

virus: Any of a group of ultramicroscopic biological infectious agents that reproduce only in living cells; therefore considered evidence of human pollution.

volatile solids: The quantity of solids in water, sewage or other liquid lost on ignition of the total solids at 600° C.

waste load allocation: A waste load allocation for a stream segment is the assignment of target pollutant loads to point and nonpoint sources so as to achieve water quality standards in the most effective manner.

wastewater reclamation: The process of treating salvaged water

from municipal, industrial, or agricultural wastewater sources for beneficial uses, whether by means of special facilities or through natural processes.

water control (soil and water conservation): The physical control of water by such measures as conservation practices on the land, channel improvements, and installation of structures for water retardation and sediment detention.

water desalination: The removal of dissolved salts from a saline water supply.

water quality: A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

water quality limited segments: "Any segment where it is known that water quality does not meet applicable water quality standards, and is not expected to meet applicable water quality standards even after the application of the effluent limitations required by sections 201 (b) (1) (A) and 301 (b) (1) (B) of the Act." (40 CFR 130.11 (d) (1)).

water right: A legally protected right to take possession of water occurring in a water supply and to divert that water and put it to beneficial use.

watershed: The region drained by or contributing water to a stream, lake, or other body of water.

water table: The upper surface of the free groundwater in a zone of saturation except when separated by an underlying of groundwater by unsaturated material.

wet weather flow: A combination of Dry weather flows, infiltration, and inflow which occurs as a result of rainstorms.

windbreak: (1) A living barrier of trees or combination of trees and shrubs located adjacent to farm or ranch headquarters and designed to protect the area from cold or hot winds and drifting snow. Also headquarters and livestock windbreaks. (2) A narrow barrier of living trees or combination of trees and shrubs, usually from one to five rows, established within or around a field for the protection of land and crops. May also consist of narrow strips of annual crops, such as corn or sorghum.

zero pollution: A degree of pollution control or prevention which eliminates the addition of any contaminants or unwanted foreign material into surface water sources; incorrectly interpreted as "zero discharge" of any effluents into watercourses (land application of wastewater effluents has been suggested as one means of establishing "zero pollution" conditions).

SECTION 12

APPENDICES

Table of Contents

Appendix A	"Standards of Quality for classification of waters of the state."
Appendix B	Survey Questionnaire - Inventory Data
Appendix C	Characteristics of Problem Areas and Receiving Waters

STATE OF RHODE ISLAND
AND
PROVIDENCE PLANTATIONS
DEPARTMENT OF HEALTH
DIVISION OF WATER POLLUTION CONTROL
WATER QUALITY CRITERIA FOR CLASSIFICATION
OF WATERS OF THE STATE
ADOPTED 1967, revised 1973, 1975, 1977

GENERAL POLICY

The following are the criteria of water quality adopted for use in the classification of the waters of the state. In classification of the waters, consideration is given to all factors involved, including public health, public enjoyment, propagation and protection of fish and wildlife, and economic and social development. Classifications are not intended to permit indiscriminate waste disposal or to allow minimum efforts of waste treatment under any circumstances.

In the discharge of waste treatment plant effluents to the receiving waters, cognizance shall be given both in time and distance to allow for mixing of effluent and stream. Such distances required for complete mixing shall not affect the water usage Class adopted but shall be defined and controlled by the regulatory authority.

ANTIDegradation

I. No new discharges permitted into Class A, SA, B, or SB waters. This prohibition shall not apply where it is demonstrated by the applicant to the state that the discharge under most adverse conditions will not impair any usages specifically assigned to the class and the waters will not be degraded below existing classification. Most adverse conditions shall include but not limited to minimum dilution predictable and complete disruption in operation at any treatment system. This prohibition shall not apply to normal stormwater drainage.

II. Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at such high quality unless it has been affirmatively demonstrated to the Director and after a public hearing that a change is justifiable as a result of necessary economic or social development and will not result in a significant loss of a use presently possible in such waters. Any industrial, public, or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required to provide the highest and best practicable means of waste treatment to maintain high water quality. In implementing this policy, the Administrator of the Federal Environmental Protection Agency will be kept advised and will be provided with such information as he will need to discharge his responsibilities under the Federal Water Pollution Control Act, as amended.

In the review of EPA NPDES permits, no approval will be given unless or until the Director has information on existing water quality for the substances to be discharged.

STATE OF RHODE ISLAND
DEPARTMENT OF HEALTH
DIVISION OF WATER POLLUTION CONTROL
WATER QUALITY CRITERIA FOR FRESH WATERS

Item	Class A	Class B	Class C	Class D
	Suitable for water supply and all other water uses; character uniformly excellent.	Suitable for bathing, other recreational purposes, agricultural uses, industrial processes and cooling; excellent fish and wild life habitat; good aesthetic value; acceptable for public water supply with appropriate treatment.	Suitable for fish and wild life habitat, recreational boating, and industrial processes and cooling; good aesthetic value.	Suitable for navigation, power, certain industrial processes and cooling, and migration of fish; good aesthetic value.
1. Dissolved oxygen	75% saturation, 16 hours/day, but not less than <u>5 mg/l at any time.</u>	75% saturation, 16 hours/day, but <u>not less than 5 mg/l at any time.</u>	Minimum 5 mg/l any time. Normal seasonal and diurnal variations above 5 mg/l will be maintained. For sluggish eutrophic waters, not less than 4 mg/l at any time. Normal seasonal and diurnal variations above 4 mg/l will be maintained.	A minimum of 2 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oils-grease-scum	None allowable	None allowable	None (See Note 7)	None (See Note 7)
3. Color and turbidity	None other than of natural origin. Not to exceed 5 Jackson Units (5 JU).	None in such concentrations that would impair any usages specifically assigned to this Class. Not to exceed 10 JU.	None in such concentrations that would impair any usages specifically assigned to this Class. Not to exceed 15 JU.	None in such concentrations that would impair any usages specifically assigned to this Class

FRESH WATER (Continued)

Item	Class A	Class B	Class C	Class D
4. Coliform bacteria	Not to exceed a median of 100 per 100 ml nor more than 500 in more than 10% of samples collected (See Note 12)	Not to exceed a median of 1,000 per 100 ml nor more than 2,400 in more than 20% of samples collected (See Note 12)	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class
5. Fecal coliform bacteria/100 ml	(See Note 12)	(See Note 12)		
6. Taste and odor	None other than of natural origin	None in such concentrations that would impair any usages specifically assigned to this Class nor cause taste and odor in edible portions of fish	None in such concentrations that would impair any usages specifically assigned to this Class nor cause taste and odor in edible fish	None in such concentrations that would impair any usages specifically assigned to this Class
7. pH	As naturally occurs	6.5 - 8.0, or as naturally occurs.	6.0 - 8.5	6.0 - 9.0
8. Allowable temperature increase	None other than of natural origin	Only such increases that will not impair any usages specifically assigned to this Class (See Note 6)	Only such increases that will not impair any usages specifically assigned to this Class or causes the growth of unfavorable species of biota.	None except where the increase will not exceed the recommended limits on the most sensitive water use and in no case exceed 90°F.
9. Chemical constituents	(See Note 5)	(See Note 5)	(See Note 5)	(See Note 5)

NOTES: FRESH WATER

1. These Standards do not apply to conditions brought about by natural causes.
2. Class D waters will be assigned only where a higher water use Class cannot be attained after all appropriate waste treatment methods are utilized. Appropriate waste treatment shall be secondary treatment with disinfection or the equivalent.
3. All sewage treatment plant effluents shall receive disinfection before discharge into a watercourse.
4. Any water falling below the standards of quality for a given Class shall be considered unsatisfactory for the uses indicated for that Class. Waters falling below the standards of quality for Class D shall be Class E and considered to be in a nuisance condition.
5. Chemical Constituents
 - a. Waters shall be free from chemical constituents and radio-active materials in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate most sensitive and governing water class use or unfavorably alter the biota.
 - b. In areas where fisheries are the governing considerations and approved limits have not been established, bioassays shall be performed as required by the appropriate agencies. The latest edition of the federal publication Water Quality Criteria will be considered in the interpretation and application of bioassay results. Bioassays shall be performed according to the latest edition of Standard Methods for the Examination of Water and Wastewater (APHA).
 - c. Phosphorus Concentration - none in such concentration that would impair any usages specifically assigned to said Class. New discharges of wastes containing phosphates will not be permitted into or immediately upstream of lakes or ponds. Phosphates shall be removed from existing discharges to the extent that such removal is or may become technically and reasonably feasible.
 - d. For public drinking water supplies, the limit prescribed by the United States Environmental Protection Agency will be used where not superseded by more stringent state requirements.
 - e. The latest edition of Environmental Protection Agency Quality Criteria for Water, the latest edition of Water Quality Criteria State of California, and other scientifically acceptable criteria will be used as guidelines in assessing impacts of chemical constituents in the issuance of permits and implementing other water quality improvement programs.

6. The temperature increase shall not raise the temperature of the receiving waters above the recommended limit on the most sensitive receiving water use and in no case exceed 83°F. In no case shall the temperature of the receiving water be raised more than 4°F. Heated discharges into designated trout habitats shall not raise the temperature above 50°F during October to 15 June nor greater than 54°F, 15 June through September.
7. Sludge deposits, floating solids, oils, grease and scum shall not be allowed except for such small amounts that may result from the discharge of appropriately treated sewage or industrial waste effluents.
8. The minimum average daily flow for seven consecutive days that can be expected to occur once in ten years shall be the minimum flow to which the standards apply.
9. Class B and C waters shall be substantially free of pollutants that:
 - a. Undesirably affect the composition of bottom aquatic life,
 - b. Undesirably affect the physical or chemical nature of the bottom,
 - c. Interfere with the propagation of desirable aquatic life.
10. Class A waters in use for drinking water supply may be subject to restricted use by State and local authorities.
11. The latest edition of Standard Methods for Examination of Water and Wastewater, APHA, will be followed in the collection, preservation, and analysis of samples. Where a method is not given, the latest procedures of the American Society for Testing Material (ASTM) will be followed. Other methods recommended by the Environmental Protection Agency (EPA) can be used, if legally acceptable.
12. As a guideline, pending further research, a fecal coliform criteria for Class A waters of a median of 20 per 100 ml, not more than 200 per 100 ml in more than 10% of the samples collected, and for Class B waters a median value of 200 per 100 ml, not more than 500 per 100 ml in more than 20% of the samples collected, will be used.
13. In the case of thermal discharges, where mixing zones are allowed, the mixing zone will be limited to no more than 1/4 of the cross sectional area and/or volume of flow of stream or estuary, leaving at least 3/4 free as a zone of passage.
14. All small streams tributary to Class A waters shall be Class A. All other small streams where the classification is not indicated shall be Class B.

STATE OF RHODE ISLAND
DEPARTMENT OF HEALTH
DIVISION OF WATER POLLUTION CONTROL
WATER QUALITY CRITERIA FOR SEA WATER

Item	Class SA	Class SB	Class SC
	Suitable for all sea water uses including shellfish harvesting for direct human consumption (approved shellfish areas), bathing and other water contact sports.	Suitable for bathing, other recreational purposes, industrial cooling and shellfish harvesting for human consumption after depuration (restricted shellfish areas); excellent fish and wild life habitat; good aesthetic value.	Suitable fish, shellfish and wild life habitat; suitable for recreational boating, and industrial cooling; good aesthetic value.
1. Dissolved oxygen	Not less than 6.0 mg/l at any time	Not less than 5.0 mg/l at any time	Not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 4 mg/l at any time
2. Sludge deposits- solid refuse- floating solids- oils-grease- scum	None allowable	None allowable	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment
3. Color and turbidity	None in such concentrations that will impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class	None in such concentrations that would impair any usages specifically assigned to this Class
4. Coliform bacteria per 100 ml	Not to exceed a median MPN of 70 and not more than 10% of the samples shall ordinarily exceed an MPN of 230 for a 5-tube decimal dilution or 330 for a 3-tube decimal dilution	Not to exceed a median value of 700 and not more than 2300 in more than 10% of the samples	None in such concentrations that would impair any usages specifically assigned to this Class

SEA WATER (Continued)

Item	Class SA	Class SB	Class SC
5. Fecal coliform bacteria/100 ml	(See Note S.9)	(See Note S.9)	
6. Taste and odor	None allowable	None in such concentrations that would impair any usages specifically assigned to this Class and none that would cause taste and odor in edible fish or shellfish	None in such concentrations that would impair any usages specifically assigned to this Class and none that would cause taste and odor in edible fish or shellfish
7. pH	6.8 - 8.5	6.8 - 8.5	6.5 - 8.5
8. Allowable temperature increase	(See Note S.10)	(See Note S.10)	(See Note S.10)
9. Chemical constituents (See Note S.4)	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other uses	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, or impair the water for any other usage assigned to this Class	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, or impair the water for any other usage assigned to this Class
10. Radioactivity	(See Note S.7)	(See Note S.7)	(See Note S.7)

NOTES: SEA WATER

- S - 1 Sea waters are those waters subject to the rise and fall of the tide.
- S - 2 All sewage treatment plant effluents shall receive disinfection before discharge to sea waters.
- S - 3 The water quality standards do not apply to conditions brought about by natural causes.
- S - 4 The waters shall be substantially free of pollutants that will:
 - a. Unduly affect the composition of bottom fauna,
 - b. Unduly affect the physical or chemical nature of the bottom,
 - c. Interfere with the propagation of fish and shellfish,
 - d. Undesirably alter the qualitative and quantitative character of the biota.
 - e. The latest edition of Environmental Protection Agency Water Quality Criteria for Water, the latest edition of Water Quality Criteria State of California, and other scientifically acceptable criteria will be used as guidelines in assessing impacts of chemical constituents in the issuance of permits and implementing other water quality improvement programs.
- S - 5 Bacteriological surveys of sea waters should include sampling during periods when the most unfavorable hydrographic and pollution conditions prevail.
- S - 6 Any water falling below the standards of quality for a given Class shall be considered unsuitable for the uses indicated for that Class. Waters falling below the standards of quality for Class SD shall be Class SE and considered to be in a nuisance condition.
- S - 7 The level of radioactive materials in all waters shall not be in concentrations or combinations which would be harmful to human, animal or aquatic life, or result in concentration in organisms producing undesirable conditions.
- S - 8 In the case of thermal discharges into tidal rivers or estuaries, where mixing zones are allowed, the mixing zone will be limited to no more than 1/4 of the cross sectional area and/or volume of flow of stream or estuary, leaving at least 3/4 free as a zone of passage. In wide estuaries and oceans, the limits of mixing zones will be established by the Director.
- S - 9 As a guide, pending further research, for Class SA waters a fecal coliform criteria of a median value of 15 per 100 ml not more than 10 percent of the samples exceeding 50 per 100 ml and for Class SB waters and a fecal coliform criteria of a median value of 50 per 100 ml and not more than 500 per 100 ml in 10 percent of the samples collected, will be used.

- S - 10 Temperature increase: None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83°F or in any case raise the normal temperature more than 1.5°F, 15 June through September and not more than 4°F from October through 15 June at the boundary of such mixing zones as is found to be reasonable by the Director.
- S - 11 The latest edition of the federal publication Water Quality Criteria will be considered in the interpretation and application of bioassay results. Bioassays will be performed according to the latest edition of Standard Methods for the Examination of Water and Wastewater (APHA).
- S - 12 The latest edition of Standard Methods for Examination of Water and Wastewater, APHA, will be followed in the collection, preservation, and analysis of samples. Where a method is not given, the latest procedures of the American Society for Testing Materials (ASTM) will be followed. Other methods recommended by the Environmental Protection Agency (EPA) can be used, if legally acceptable.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF HEALTH

DIVISION OF WATER POLLUTION CONTROL

PROPOSED CHANGES IN WATER QUALITY CLASSIFICATIONS - FRESH WATER

<u>River Section</u>	<u>Existing Classification</u>	<u>Proposed Classification</u>
Clear River from Harrisville Dam to a point 1 mile upstream from confluence with Chepachet River (1.4 miles)	C	B
Pawtuxet River from the confluence with the Pocasset River to the Pawtuxet Cove Dam (4 miles)	D	C
Unnamed brook tributary to Pawtuxet River, Warwick (Pawtuxet Village), RI (0.5 miles)	C	B
Saugatucket River from Kingston Road in Peace Dale to the Main Street Dam in Wakefield (1.1 miles)	C	B
Woonasquatucket River from the outlet of Slack's Reservoir to the inlet of Stillwater Reservoir (2 miles)	C	B
Woonasquatucket River from Georgiaville to Greystone Dam Road 0.2 miles north of the Smithfield/North Providence line (1.4 miles)	C	B

PROPOSED CHANGES IN WATER QUALITY CLASSIFICATION - SEA WATER

<u>Area</u>	<u>Existing Classification</u>	<u>Proposed Classification</u>
Upper Narragansett Bay in the vicinity of North Farm on the Bay south of line from the northermost extremity of the breakwater at the North Farm marina easterly to the shore, and east and north of the breakwater at the North Farm marina (5Acres)	SA	SB
The waters in the vicinity of Quonset Point within 1,500 feet of shore from the western end of the carrier pier to		

<u>Area</u>	<u>Existing Classification</u>	<u>Proposed Classification</u>
a point 1,000 feet north of Quonset Point (148 Acres)	SB & SC	SC
The waters in the vicinity of Quonset Point, exclusive of those waters described above, north and east of a line from the southeastern corner of the boundary fence at Electric Boat to General Rock buoy, north of a line from Sauga Point to Buoy (Fl 4 sec)3, north and west of a line from Buoy (Fl 4 sec)3, to Buoy (Qk Fl)13, north and west of a line from Buoy (Qk Fl)13, to Buoy (Qk Fl R)12, west of a line from Buoy (QK Fl R)12, to nun buoy 18 and south and west of a line from nun buoy 18 to a point approximately 3,000 feet north of Quonset Point (459 Acres)	SA,SB,SC	SB
Former SB areas around Quonset Point (296 Acres)	SB	SA
The waters within 1,000 feet of any point on the shore line of Gould Islands (250 Acres)	SC	SA
The waters in the vicinity of Coasters Harbor which are within 500 feet of the Newport marine outfall sewer (18 Acres)	SB	SC
The waters in the vicinity of Taylor Point which are within 300 feet of the Jamestown marine outfall sewer (7 Acres)	SA	SC
The waters in the vicinity of Taylor Point, exclusive of those waters described above, south of a line from the northernmost extremity of Taylor Point to can buoy 13, north of a line from a point of land approximately 1,000 feet south of the Newport Bridge to the northernmost extremity of Rose Island, and within 1,000 feet of the shoreline of Jamestown (49 Acres)	SA	SB
The waters in the vicinity of East Ferry west of a line from Bryer Point to a point approximately 1,500 feet south of Narragansett Avenue (61 Acres)	SC	SB

<u>Area</u>	<u>Existing Classification</u>	<u>Proposed Classification</u>
The waters in the vicinity of Wharton's Shipyard which are south and west of a line from a point of land approximately 3,000 feet north of Bull Point to the northernmost of "the Dumplings", and west of a line from the northernmost of the "Dumplings" to a point of land approximately 1,000 feet north of Bull Point (17 Acres)	SA	SB
The waters in the vicinity of South Ferry within 500 feet of the University of Rhode Island Narragansett Bay Campus Marine Outfall sewer (9 Acres)	SB	SC
The waters in the vicinity of Condon Street at Narragansett Pier, Narragansett (28 Acres)	SC	SA
The waters in the vicinity of Tucker's Dock which are within 500 feet of the South Kingstown/Narragansett Regional Sewage Treatment Plant outfall (18 Acres)	SA	SC
The waters in the vicinity of Tucker's Dock, exclusive of those waters described above, which are within 2,500 feet of any point on the shoreline between Continental Road and Hazard Avenue (207 Acres)	SA	SB
The waters in the vicinity of Scarborough within 500 feet of the marine outfall sewer located approximately 2,000 feet, bearing 133° from a point of land at the northern boundary of Fort Nathaniel Greene (18 Acres)	SB	SC
The waters in the vicinity of Scarborough which are more than 500' but less than 1,500' away from the marine outfall sewer located approximately 2,000 bearings 133° from a point of land at the northern boundary of Fort Nathaniel Greene (144 Acres)	SA & SB	SB

<u>Area</u>	<u>Existing Classification</u>	<u>Proposed Classification</u>
Upper Point Judith Pond north of Can Buoy 25 including the Saugatucket River downstream of the Main Street Dam (43 Acres)	SC	SB
The waters in the vicinity of Galilee within 500 feet of the shore from the breachway to a point approximately 600 feet west of Great Island Road (39 Acres)	SA	SB
The waters in the vicinity of Jerusalem within 500 feet of the shore from the breachway to a point approximately 1,000 feet north of the State Pier (23 Acres)	SA	SB
The waters in the vicinity of Snug Harbor within 500 feet of shore from Gooseberry Road to High Point (24 Acres)	SA	SB
The waters in the vicinity of Old Harbor which are within 500 feet of the Block Island marine outfall sewer (12 Acres)	SA & SB	SC
The waters in the vicinity of Old Harbor, exclusive of the waters described above, which are within 1,000 feet from shore from a point 1,000 feet north of the Block Island marine outfall sewer to a point 1,000 feet south of the marine outfall sewer (31 Acres)	SA & SB	SB
The waters in the vicinity of Old Harbor west of a line from the fixed red light at the end of the northern breakwater to the shore at Pebbly Beach which are not included in the SB & SC areas above (23 Acres)	SB	SA

Appendix B - Survey Questionnaire - Inventory Data

- A. Land Use Maps (present and future)
- B. Population Projections (present and future)
- C. Codes or other pertinent Legislation concerning
Runoff/Litter/Chemicals
- D. Results of any Stormwater Analysis
- E. Typical Catch Basin Detail Drawing
- F. Overflow Structure Drawings
- G. Methods of Runoff Analysis required by Municipality
- H. Problem Areas
- I. Future Plans for Stormwater Related Projects.
- J. Stormwater & Combined Sewer System Maps.

SURVEY - LITTER

City _____ State _____ Date _____
 Prepared by _____ Title _____ Dept. _____
 Mailing Address _____

A. Please rate the following factors, which may be controlled or altered by the action of public officials, and result in a more attractive waste-free urban community, in their order of importance from 1 to 26 as related to your community. Please use number one (1) to indicate most serious. Use each number once only.

Item	Rating in Order (See A- above)	Check (when applicable) if controlled by existing ordinance	Check (when applicable) if existing ordinance enforced	Check if penalties are acces- sed on of- fenders	Check if not a problem in your city
a. Spillage from overloaded trucks	_____	_____	_____	_____	_____
b. Litter from parades and large public events	_____	_____	_____	_____	_____
c. Disintegration of poorly surfaced streets	_____	_____	_____	_____	_____
d. Lack of paving at driveway and alley entrances	_____	_____	_____	_____	_____
e. Yard refuse (leaves, lawn clippings)	_____	_____	_____	_____	_____
f. Animal droppings	_____	_____	_____	_____	_____
g. Deposition from windstorms	_____	_____	_____	_____	_____
h. Improperly used trash receptacles	_____	_____	_____	_____	_____
i. Improper storage of household refuse	_____	_____	_____	_____	_____
j. Debris from construction and demolition	_____	_____	_____	_____	_____
k. Roadside dumping	_____	_____	_____	_____	_____
l. Lack of satisfactory street cleaning equipment	_____	_____	_____	_____	_____
m. Poor refuse collection practices	_____	_____	_____	_____	_____
n. Street trees, type or placement	_____	_____	_____	_____	_____
o. Lack of catch basin and storm water inlet maintenance	_____	_____	_____	_____	_____
p. Air pollution	_____	_____	_____	_____	_____
q. Droppings from vehicles (grease, oil, etc.)	_____	_____	_____	_____	_____
r. Poor public cooperation	_____	_____	_____	_____	_____
s. Lack of adequate public trash receptacles	_____	_____	_____	_____	_____
t. Lack of public education	_____	_____	_____	_____	_____
u. Inadequate budget for street cleaning	_____	_____	_____	_____	_____

v. Other (Specify) _____

w. Other _____

x. Other _____

y. Other _____

z. Other _____

B. Street Cleaning Frequency (days per week, weekly, monthly, etc.) (Check)

Type Street	Miles as Classified	Total curb miles swept Annually	Frequency designate (daily-weekly-monthly)		Year Round	No Winter Sweeping
			Flushed	Swept		
Residential	_____	_____	_____	_____	_____	_____
Commercial	_____	_____	_____	_____	_____	_____
Downtown business	_____	_____	_____	_____	_____	_____
Arterial (4 or more lanes)	_____	_____	_____	_____	_____	_____
Industrial	_____	_____	_____	_____	_____	_____
Park roads	_____	_____	_____	_____	_____	_____
Private (if applicable)	_____	_____	_____	_____	_____	_____
Other (specify)	_____	_____	_____	_____	_____	_____

C. Amount of Street Refuse

1. Area served _____ Population served _____

	Volume Cu. yds.	Weight Tons	(If by City (Check); If by contract - Specify)
Annual amount street refuse removed	_____	_____	_____
Annual amount from litter receptacles removed	_____	_____	_____
Annual amount leaves & yard trim- mings removed (from streets)	_____	_____	_____

D. Annual Labor for Street Refuse Removal

Period _____

	Total Hours	
	Labor	Equipment
Hand sweeping	_____	_____
Mechanical flushing	_____	_____
Mechanical sweeping	_____	_____
Disposal of sweepings	_____	_____
Catch basin cleaning	_____	_____
Litter basket emptying	_____	_____
Other	_____	_____
TOTAL	_____	_____

E. Refuse Sanitation Inspection Activities

1. Inspection activities are carried out by public works department _____ police department _____ Health department _____ Other _____
2. Number of city refuse sanitation inspectors assigned to:

<u>Type area</u>	<u>Number of equivalent full time employees</u>
Residential	_____
Commercial	_____
Industrial	_____
3. Primary function of inspector is to require proper placement of refuse _____
require proper containers for refuse _____
improve customer relations _____
enforce collection standards _____
other _____
4. Performance of inspector is judged by (title) _____
5. Litter control activities are coordinated by (title) _____
6. Placement of litter baskets is determined by (title) _____
7. (Check one) Private _____ Public _____ Contract _____ Collects contained residential
8. (Check one) Private _____ Public _____ Contract _____ Collects commercial
9. (Check one) Private _____ Public _____ Contract _____ Collection industrial

F. Other comments (if any) _____

SURVEY - STORM SEWER SOLIDS

City _____ State _____ Date _____

Prepared by _____ Title _____ Department _____

Mailing Address _____

I. General Information

	Area Served (sq. mi.)	Population served	Length Sewers* (Miles)
Sanitary Sewers	_____	_____	_____
Storm Sewers	_____	_____	_____
Combined Sewers	_____	_____	_____
TOTAL	_____	_____	_____

Average annual rainfall _____ in. Annual average snowfall _____ in.
or _____ equivalent in. of rainfall

(*Omit house connections)

II. Points of solid removal

A. Catch basins

- Are catch basins used: Yes _____ No _____
- Are catch basins currently required on new storm sewers: Yes _____ No _____
- Are catch basins cleaned by Sewer Dept. Yes _____ No _____
by Street Dept./Div. Yes _____ No _____ or other (specify) _____
- Approximate number of catch basins _____
- Have regular cleaning policy: Yes _____ No _____
If yes, please attach copy of policy.
- Approximate annual volume solids removed _____ cu. yds.
How determined? _____
What are neighborhood characteristics most effecting amount of solids?

- Annual: Salaries _____ Equipment _____ Other _____
Total _____
- No. and composition of catch basin cleaning crews: Number _____ (Describe crew and equipment) _____

Total man hours/year _____
Frequency of cleaning catch basins _____ times/year

9. What type of trap do you use on catch basin? _____
 What was basis for selection of type of trap? _____

Please attach copy of standard drawing.

10. Principal source of solids believed to be from _____

 11. Where and how do you dispose of the solids collected? _____

 12. Do you contract with private firms to clean catch basins? Yes _____ No _____
 If yes, per cent of work done by contract _____ %, annual cost of contract
 \$ _____

B. Sewer Cleaning

	Combined Sewers	Sanitary Sewer	Storm Sewer
1. Estimated infiltration			
(a) gal./in-diam./mile	_____	_____	_____
(b) total m.g.d. (for the system)	_____	_____	_____
2. Miles in system			
(a) 6-12" diameter	_____	_____	_____
(b) 15-24" diameter	_____	_____	_____
(c) 27-72" diameter	_____	_____	_____
(d) over	_____	_____	_____
3. Average volume of solids removed per mile (cu. yds.) per year	_____	_____	_____
4. Annual equipment and labor			
	Crew Size	Man Hours	Type equipment used
Combined	_____	_____	_____
Sanitary	_____	_____	_____
Storm	_____	_____	_____
TOTAL	_____	_____	_____
5. Volume dry weather flow in storm sewers (m.g.d.)	_____		

COASTAL ZONE

FEB 1961

C. Overflow diversion chambers on combined systems (answer only for combined sewers)

1. Do you have equipment installed to indicate when overflow occurs?

Yes _____ No _____ If yes, please describe _____

2. Usual overflow setting: _____ X dry weather flow

3. Special maintenance problems encountered _____

4. Have you determined if there is unused capacity in the interceptor system?

Yes _____ No _____ If yes, how _____

D. Grit removal

1. Sewage treatment plant has provisions for grit removal. Yes _____ No _____

If yes:

2. Annual volume of solids removed (cu. yds.) _____

3. Special problems encountered _____

4. Annual operation cost of grit removal _____

E. Outfall removal

1. Dredging or other removal activities at sewer outfall required: Yes _____ No _____

If yes:

2. Frequency of removal (per year) _____

3. Volume removed (cu. yds./year) _____

4. Describe nature of material _____

5. Where is material disposed _____

6. Annual cost _____ Annual man hours _____

F. Other comments (if any) _____

G. For sewer system please check allowable connections for discharge of:

	Combined		Storm		Sanitary	
	Yes	No	Yes	No	Yes	No
Swimming pools	—	—	—	—	—	—
Foundation drains	—	—	—	—	—	—
Roof drains	—	—	—	—	—	—
Sump pump	—	—	—	—	—	—
Cooling water	—	—	—	—	—	—
Ind. process water (treated)	—	—	—	—	—	—
Ind. process water (untreated)	—	—	—	—	—	—

SURVEY - CHEMICALS

A. Deicing Agents

Major active ingredients or identification	Annual Amount Used (Tons)	Roadway Miles Covered
_____	_____	_____
_____	_____	_____
_____	_____	_____

B. Chemical Fertilizers Used:

Major active ingredients or identification	Annual Amount Used (Tons)	Area Covered (Acres)
_____	_____	_____
_____	_____	_____
_____	_____	_____

C. (Check one) This report covers the use of all such chemicals by the city: Yes _____ No _____ If no, to whom would additional copies be sent? _____

Mailing address _____

D. What city official determines the chemical to be used? _____

E. What city official determines the amount of chemical to be used? _____

F. On what basis is the type and amount selected? _____

G. Is there any evidence in your city of stream pollution or fish kill caused by runoff from storm sewers carrying dissolved chemicals? Yes _____ No _____

H. Has any action been taken by the city to eliminate or reduce this pollution or fish kill?

Explain _____

SURVEY - CHEMICALS (CONTINUED)

I. Other comments (if any) _____

SURVEY - POLLUTANT ACCUMULATION AND CONTENTS

Land Use	Dust and Dirt Accumulation Rate lb/day/100ft gutter	Pollutant Fractions lbs pollutant/100 lb dust and dirt					
		SUS SOLIDS	SET SOLIDS	BOD	NIT	PO ₄	COLIFORMS 10 ⁵ MPN
Single Family Residence							
Multiple Family Residence							
Commercial							
Industrial							
Open Space/ Parks							

Survey - Dry Weather Flow in Combined Sewer Systems

- A. Average daily flow from residential,
commercial and industrial sources in MGD _____
- B. Average dialy total suspended solids load
in lbs/day _____
- C. Average daily total settleable solids load
in lbs/day _____
- D. Average daily total BOD load in lbs/day _____
- E. Average daily total nitrogen loads in
lbs/day _____
- F. Average daily total orthophosphate load
in lbs/day _____
- G. Average daily total coliform organisms
load in billion MPN/day _____

FEB 1 1978

COASTAL ZONE
INFORMATION CENTER

APPENDIX C

PROBLEM AREA	RECEIVING WATER AFFECTED	LAND USES* IN PROBLEM AREA	SEVERITY OF EFFECT IN RECEIVING WATER
Newport	Almy Pond Lilly Pond Easton Pond Newport Harbor Coasters Harbor	L, P, A, D A, W, P, L, R, D A, L, C, P, D C, P, D, T, R, L L, P, D, T	Slight Slight Moderate Great Slight
Newport/Middletown	Coddington Cove Green End Pond	D, P, R, T, A, F C, T, R, P, L, A, D, F, W	Moderate Moderate
Portsmouth (Melville)	Coggeshall Cove Melville Ponds	T, P, F D, A, R, L, F	Slight Slight
Portsmouth Island Park Area	Sakonnet River	D, C, P, T, A, L, F	Moderate
Bristol Center	Bristol Harbor	C, D, J, W, A, R, L, F	Moderate
Warren Center	Warren River Belcher Cove	C, D, J, F, T, A, L, W C, D, J, R, P, A, L, W	Moderate Moderate
East Side of Warren	Warren Reservoir	D, L, P, A, W	Moderate
Barrington River Basin	Barrington River	C, T, N, A, L, F, P, S	Slight
Barrington Beach Area	Hyde Hole	L, R, S, A, W, F, P	Slight
East Providence & Barrington	Bullock Cove	D, C, J, A, R, F, L, P, S	Great
Riverside	Providence River	D, C, J, T, A, R, F, P, W	Great

*See Land Use Map Legend for Code Meaning.

PROBLEM AREA	RECEIVING WATER AFFECTED	LAND USES IN PROBLEM AREA	SEVERITY OF EFFECT IN RECEIVING WATER
East Providence	Seekonk River	D, C, J, T, R, L, F, P, S	Great
Providence (East Side)	Seekonk River	D, C, J, T, R, L, F, P	Great
Pawtucket (East Side)	Seekonk River	D, C, J, T, R, L, F, P, S	Great
	Blackstone River	D, C, J, T, R, L, F, P, S	Great
Providence (City)	Providence River	D, C, J, T, P, F	Great
	Woonasquatucket River	D, C, J, T, P, F	Great
	Moshassuck River	D, C, J, T, P, F	Great
	West River	D, C, J, T, P, F	Great
North Providence	Upper Canada Pond	D, C, J, T, P, F, L	Great
Pawtucket (West)	Moshassuck	D, C, J, T, P, F, L	Great
Providence (South)	Providence River	D, C, J, T, L, P, R, F	Great
Olneyville Providence	Woonasquatucket River	D, C, J, T, L, P, R, F	Great
North Providence (West Side)	Woonasquatucket River	D, C, J, T, P, R, F, A	Great
Esmond-Smithfield	Woonasquatucket River	D, C, J, F, L	Moderate
Elmwood-Providence	Mashapaug Pond	D, J, T, C, P	Great
Northeast Cranston	Spectacle Pond	D, J, T, C, P	Great
Edgewood Cranston	Providence River	D, F, C	Great
Auburn Cranston	Pawtuxet River	D, J, P, T, F	Great

PROBLEM AREA	RECEIVING WATER AFFECTED	LAND USES IN PROBLEM AREA	SEVERITY OF EFFECT IN RECEIVING WATER
Cranston Center	Pocasset River	D, J, P, T, F, R, C	Great
Hughsdale-Johnston	Pocasset River	C, T, F, A, L, P	Slight
Meshanticut-Cranston	Meschanticut Bk.	D, C, T, F, P, L, S, A	Moderate
Norwood & Lakewood Warwick	Pawtuxet River	D, C, J, T, A, F, P, W, L	Great
Central Falls-West	Blackstone River	C, J, D, P, R, F, W	Great
Central Falls-East	Moshassuck River	C, D, J, L, F, W, P	Great
Northwestern Pawtucket	Ten Mile River	C, J, F, P, L, W	Slight
Southeast Blackstone	Harris Pond	D, T, J, P	Moderate
Woonsocket	Blackstone River	D, C, J, T, P, L, F	Great
Slatersville-North Smithfield	Branch River	D, J, L, F, S, A	Slight
Harrisville	Clear River	D, P, C, A, L, F	Slight
Simmons ville	Simmon Reservoir	W, S, A, F, L	Slight
Eastern Warwick	Narragansett Bay	D, C, L, F, R, P, A	Slight
Hoxsie-Warwick	Spring Green Pond	D, C, A, F, P, L	Great
Airport-Warwick	Warwick Pond Buckeye Brook	D, C, L, F, T, P, A, J D, C, L, F, T, P, A, J	Great Great

PROBLEM AREA	RECEIVING WATER AFFECTED	LAND USES IN PROBLEM AREA	SEVERITY OF EFFECT IN RECEIVING WATER
Oakland Beach	Brushneck Cove Warwick Cove	D, C, F, A, L D, C, F, L, A, R, C	Great Moderate
Hillsgrove	Three Ponds Brook	J, C, F, P, T, S, D, A	Moderate
Apponaug	Gorton Pond Apponaug Cove	D, C, A, P, F, L, T D, C, A, P, F, L, T	Moderate Moderate
Drum Rock	Hardig Brook	T, D, F, L, J, A, P, S	Slight
Natick	Pawtuxet River	D, C, J, W, L, T, P, F	Moderate
Southern Warwick	Maskechugg River	C, T, P, F, L, A, P	Slight
East Greenwich	Greenwich Cove Potowamut River Hunt River Fry Brook	C, D, J, T, A, L, F C, D, J, A, L, F, P, R, S C, D, J, A, L, F, P, R, S C, D, J, A, L, F, P, R, S	Moderate Slight Slight Slight
Hope & Fiskeville Arkwright, Harris & Clyde	North Branch Pawtuxet River	D, J, C, T, L, W, A, F	Slight
Artic	South Branch Pawtuxet River	D, C, L, J, A	Moderate
Washington	South Branch Pawtuxet River Tiogue Lake	D, C, J, A, F, L, P, R, S, T, W D, C, J, A, F, L, P, R, S, T, W	Slight Slight Slight
West Greenwich	Lake Mishnock	D, R, L, T, S, F	Slight

PROBLEM AREA	RECEIVING WATER AFFECTED	LAND USES IN PROBLEM AREA	SEVERITY OF EFFECT IN RECEIVING WATER
Quonset Point	Narragansett Bay	T,R,D,L,F,P	Slight
Naval Reservation	Mill Creek	D,L,C,A,W,T,F	Slight
Wickford	Wickford Harbor	D,L,P,C,R,F,T,J	Moderate
Sand Hill	Sand Hill Brook	D,C,J,W,P,F,R	Slight
Bonnet Shores	Wesquage Pond	D,F,C,A,W	Moderate
	Narragansett Bay	D,F,C,A,W	Moderate
Narragansett Pier	Rhode Island Sound	D,P,F,R,A	Slight
Wakefield	Silver Lake	D,C,L,T,P	Moderate
Point Judith	Point Judith Pond	D,W,R,A,T,C,L	Moderate
University of Rhode Island	Horn Brook	P,F,R,L,A	Slight
Westerly	Pawcatuck River	C,J,L,A,F,T,M	Slight

